Rail Service Challenges in the Upper Midwest: Implications for Agricultural Sectors – Preliminary Analysis of the 2013 – 2014 Situation[1]

United States Department of Agriculture

Office of the Chief Economist and

the Agricultural Marketing Service

January 2015

[1] This analysis was prepared in response to a request by Senators Thune and Klobuchar for USDA to examine rail service challenges in the Upper Midwest.

Rail Service Challenges in the Upper Midwest

Implications for Agricultural Sectors

Contents

Rail Service Challenges in the Upper Midwest Implications for Agricultural Sectors

Summary

During the fall harvest season for the 2013/14 crops[2], increased demand to ship coal, oil, intermodal containers, sand, gravel, and a combined record harvest of corn, soybeans, and wheat in the United States put added demands on the rail network. Consequently rail service delays occurred in the Upper Midwest across a number of States – particularly Minnesota, Montana, North Dakota, and South Dakota. The farmers in that region have limited local markets for the products, less access to barge or other transportation alternatives, and more limited crop storage relative to the recent expansion of corn production. Rail service available to grain shippers in those States lagged far behind shippers' demand to move the record grain harvest, forcing new crop grain into storage where available, or onto the ground, risking losses. Crop prices in those States were driven lower due to the extra costs of transportation and storage. Finally, the winter of 2014 was particularly harsh with cold temperatures often requiring rail operators to cut train lengths by as much as 50 percent, directly limiting the availability of rail services.

Using readily available data from USDA's Agricultural Marketing Service (AMS), we have examined how transportation costs may have resulted in changes to prices received by producers and shippers in the Upper Midwest relative to the prices at the ports in the Pacific Northwest (PNW) and Gulf of Mexico (GOM).

Our preliminary efforts at considering those effects suggest that transportation costs are a significant factor in explaining why local prices may be relatively high or low compared to nearby futures prices or spot prices at export destinations in the PNW or the GOM. Initial results using several examples for 2014 suggest that costs incurred by grain and oilseed producers in the Upper Midwest (Minnesota, North Dakota, Montana, and South Dakota)—above what would be expected from regular seasonal increases in transport costs and holding all else constant from January 1 to November 30—could be three percent of cash receipts.

However, it is unclear whether or not producers would have chosen to market their crop at those depressed prices. Some could have sold under a forward contract, or could have stored the crop for sale at a later date, or even sold to shippers using a different mode of transportation or destination. As such, knowing the actual impacts of rail transportation problems on those producers is difficult to determine.

[2] The crop marketing year extends from September 1 through August 31. Transportation demand can lag behind harvest with heavy increases usually beginning in October.

The destination port, commodity, and time period are also all significant in determining how much rail costs affect local prices. Even after considering those factors, results indicate that there remains a large degree of uncertainty about why prices in one location may differ from other prices geographically and over time. That makes it difficult to assign a monetary estimate of the impacts of recent transportation disruptions on local prices for wheat, corn, and soybeans.

It does not appear that the high transportation costs impeded the ability to meet our export demand. The strong pace of exports suggests that other transportation modes or routes and the storage and contracting of grain and oilseeds over time helped mitigate the rail disruptions last winter and the relatively high prices for railcars in the secondary markets this fall. Exports of grain and oilseeds in 2014 are above the 3-year average. And the extremely high price of railcars on the secondary market in recent months has fallen to more normal levels.

Nevertheless, rail service in the United States is currently operating near full capacity as the United States recovers from the recession and production of ethanol and unconventional oil and gas are near record highs. Because railroads are operating near full capacity, transportation disruptions (e.g. adverse weather conditions or an unexpected sudden surge in demand) are likely to cause performance problems for rail transport. In addition, routine track maintenance by an individual railroad may result in longer than anticipated disruptions in certain areas and can lead to delays that spill over to the larger parts of the connected rail system.

Background

Grains and oilseeds produced in the United States rely on an interconnected transportation network to move production from farm fields to final points of use in domestic and international markets. Truck, rail, and barge compete over some segments of the movement but work together over others. That complex interrelationship disciplines transportation prices, provides additional transportation modes and flexibility in service, and expands marketing options for producers. Furthermore, the competitiveness of U.S. grains in the world market and the financial well-being of U.S. grain producers depend upon that competitive balance.

Before a bushel of grain reaches its final destination, it has often been transported by two or more transportation modes. Over time, the relative market share of different transportation modes has evolved to reflect changing market structures and demands. In 1980, railroads moved half the grain and oilseed harvest, trucks moved 30 percent, and barges moved the remainder. By 2011, the rail share had declined to 28 percent while the truck share had risen to 60 percent.[3] Much of the earlier shift in market shares among modes is related to the restructuring of those industries following transportation deregulation in the 1980s. Practices such as abandonment of track, consolidation within the rail and grain industries, ease of entry into trucking, as well as

[3] Sparger, Adam, and Nick Marathon. *Transportation of U.S. Grains: A Modal Share Analysis*, May 2013. U.S. Dept. of Agriculture, Agricultural Marketing Service.

producer and elevator purchases of 18-wheel truck and trailer combinations, contributed to the rebalancing of market shares. More recently, the growth in ethanol and biodiesel production as well as the geographic concentration of animal feeding have further contributed to that phenomenon.[4]

Each mode of transport offers distinct advantages and disadvantages to the others. Trucks are highly flexible in terms of which locations they can serve and cost-effective for short-distance transportation. They are usually less costly than rail or barge within about 250 miles between origin and destination. Conversely, shippers of grain and oilseed exports favor rail and barge for the longer hauls associated with most export movements. That preference is because on a ton-mile basis, rail and barge offer significant cost savings to truck over long distances and large quantities of grain are more easily moved by rail and barge. Barges are able to offer the lowest prices on a ton-mile basis, in part, because of their immense carrying capacity—one 15-barge tow is equivalent to two 100 jumbo hopper railcar trains.[5] However, their effectiveness is limited geographically by access to navigable waterways, which varies by season. In addition, the preference for barge may also be limited when timeliness is a critical factor, due to their slower shipping speeds than rail. For example, it can take 11 days for grain to travel from Minneapolis, MN, to New Orleans, LA, by barge but only 4 days by rail.

The level and effectiveness of transportation competition can vary by locality and depend upon such factors as distance of the movement, relative prices of the transportation modes, availability of the transportation mode, and shipment size. Studies indicate transportation rates are lower when competition between barges, truck, and railroads is present. The relative price per ton among barge, truck, and rail transportation modes helps determine which transportation modes are utilized. Relative prices also determine the geographic areas commodities may be drawn from, for example how far a shipper is willing to ship grain by truck or rail in order to access a barge facility.

Agricultural Dependency on Rail

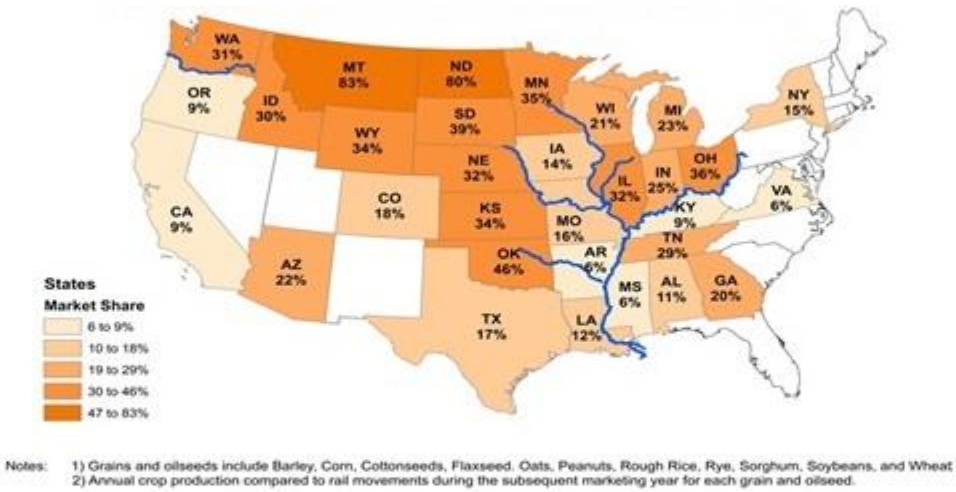
Rail service is a particularly important part of the transportation network for U.S. agriculture because it is often the most cost-effective shipping alternative available for low-value, bulky commodities in those rural areas that are distant from water transportation and markets. Grain and oilseed shippers in Montana and North Dakota are particularly dependent on rail transportation because of their distance to inland waterways and the prohibitive cost of hauling grain long distances to markets by truck and limited local demand. On average, railroads transported 83 percent of Montana and 80 percent of North Dakota grains and oilseeds during the

[4] Prater, Marvin E., Adam Sparger, Pierre Bahizi, and Daniel O'Neil, Jr., *Rail's Loss of Grain Transportation Market Share*, U.S. Department of Agriculture, Agricultural Marketing Service, December 2013. http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5105745

[5] Iowa Department of Transportation, *Barge Comparison Chart*. http://www.iowadot.gov/compare.pdf

crop marketing years from 2009 to 2012 (see figure 1). In addition, railroads transported between 30 and 46 percent of the grain and oilseed production for eight States clustered around Montana and North Dakota, such as South Dakota at 39 percent and Minnesota at 35 percent. Many States with river access—those stretching from Iowa to Louisiana—had comparatively lower rail market shares (between 6 and 32 percent).

Figure 1: Rail Marketing Share of Grain Transportation (2009 – 2012)[1, 2]



Source: AMS Analysis of Surface Transportation Board, Confidential Waybill Samples; USDA National Agricultural Statistics Service, *Crop Production Annual Report*

Seven Class I railroads operate in the United States.[6] Those carriers account for nearly 95 percent of railroad revenues, 82 percent of originated tonnage, and own 70 percent of the network, measured in route-miles. They are privately owned and also provide connections to smaller short line and regional railroads, many of which are also privately owned. [7]

There are two U.S. Class I railroads operating in the West and two in the East. The West is served by BNSF Railway (BNSF) and Union Pacific Railroad (UP). In the East, there are CSX Transportation (CSX) and Norfolk Southern Railway (NS). There are two Canadian railroads with operations in the United States that serve the central part of the nation. Those are Canadian Pacific Railway (CP) and Canadian National Railway (CN); CN also provides service to the Gulf Coast. Kansas City Southern Railway (KCS) is a smaller Class I railroad providing service in the Central and Southern United States, with significant operations extending into Mexico.

Many agricultural shippers have a range of transportation options available such as multiple railroads in competition with each other or truck and barge alternatives. There are also rail-

[6] The Surface Transportation Board defines class of railroad based on revenue thresholds adjusted for inflation. For 2013, the most recent available, Class I carriers had revenues of $467.0 million or more.
[7] Association of American Railroads, *Ten-Year Trends*, 2003-2012.

dependent areas in the Upper Great Plains served by only a single railroad. Shippers in those areas are more vulnerable to rail disruptions. Disruptions and the higher transportation costs that can accompany them are generally reflected in lower prices paid to producers for their crops. The only alternative to shipping during periods of disruptions or exceptionally high rail rates is often storing grain.

Rail Service Problems of 2013 and 2014

As the overall U.S. economy improved in 2013 and 2014, the demand for rail service increased for most commodities, including coal, oil, intermodal containers, sand, and gravel. In August 2013, Class I railroads reported to the Surface Transportation Board that they were well positioned to handle the anticipated increase in rail demand related to the fall peak in agricultural volume.[8] However, by the end of October, railroad service had degraded significantly. The record 2013/14 U.S. corn production, a sizable U.S. soybean and wheat crop, and record wheat production in Canada put more strain on the already near-capacity rail transportation system.

Service problems were particularly acute on BNSF and CP, characterized by long delays in transit, missed shipments, railcar backlogs, and higher transportation costs. BNSF was unable to handle the full increase in demand from agricultural shippers—triggered by the large harvest and in the face of a cyclical increase in aggregate rail demand from other sectors. Furthermore, locomotives and crews were in short supply, leaving many loaded grain cars sidelined for extended periods while locomotives and crews were spread thin across the network. BNSF's share of grain transported by rail dropped to the lowest level in 10 years, and bids for BNSF service in the secondary railcar market reached historic highs for both shuttle and non-shuttle service, increasing total rail transportation costs to record levels. Secondary railcar market prices indicate the relative ease or tightness of obtaining empty railcars to load.

Rail capacity was further tested by a severe winter, which compounded the already degraded rail service most grain shippers were experiencing. The effects of reduced rail capacity were most significant in the Upper Midwest in Minnesota, Montana, North Dakota, and South Dakota.

The reasons contributing to the rail service problems are discussed in more detail in the following sections.

Seasonality of Grain Shipping

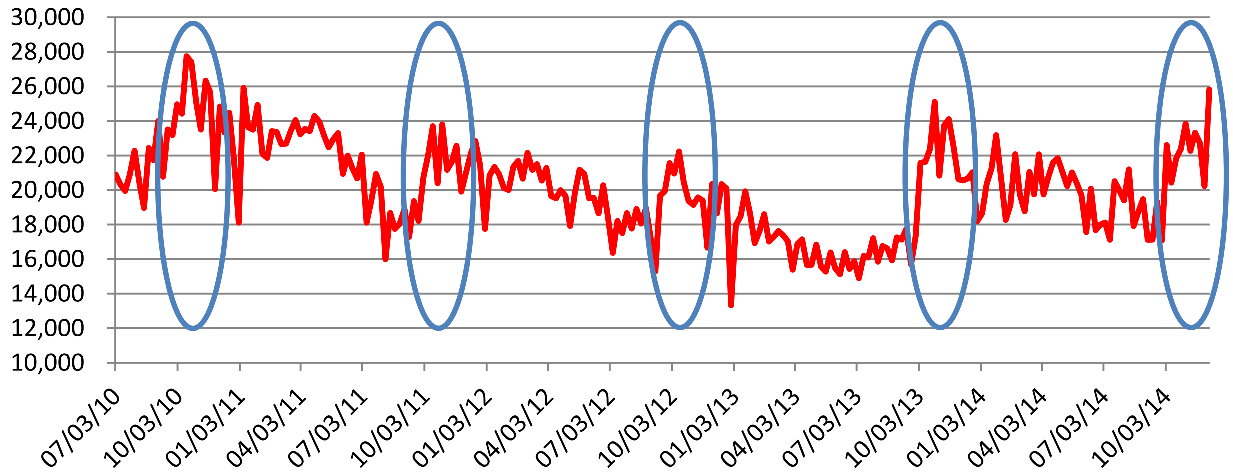
Agricultural commodities pose unique transportation challenges that are tied to the seasonality of their production. When grain is harvested in the fall, demand for grain rail service typically increases at the beginning of October (around week 40), with strong demand lasting for several months and gradually decreasing through summer. Short-term agricultural transportation supply and demand is influenced by weather-related transportation disruptions, variation in annual crop

[8] Surface Transportation Board, 2013 Fall Peak Letters

size and its location, the timing of planting and harvesting, available storage, global trade patterns, crop quality concerns, competition in production by other countries, and commodity price fluctuations. Those and other factors can translate into unexpected shifts in transportation patterns and costs, adding to the commodity price risk to be managed by agricultural producers, processors, and shippers, which together influence how much grain is shipped by rail in any given year.

The seasonality of grain shipping can add to seasonal congestion on the rail network. The typical pattern for grain shipments shows seasonal peaks occurring in October, the duration and magnitude of which are partially associated with the annual volume of grain and oilseed production (see figure 2).

Figure 2: Class I Weekly Grain Carloadings



Source: AMS Analysis of Association of American Railroads, *Weekly Railroad Traffic*

Adequate transportation and storage capacity are needed during the fall peak to minimize on-ground storage of the newly harvested crop. As opposed to covered silos, on-ground storage of grain increases its exposure to fluctuations in temperature and moisture and increases the likelihood of spoilage. Producers and elevators make long-term decisions on the level of investment in permanent on-farm and off-farm grain storage requirements based on expected returns which are in part related to the transportation network's capacity to efficiently move grain. Railroads attempt to anticipate and accommodate that fall peak season for grain, but they can be limited by the availability of additional rail capacity, the level of demand for rail service from other commodities, and the unpredictability of quantities and timing of the grain harvest. It would not be economically efficient for either the storage or rail systems to accommodate the full annual fluctuations in supply due to factors such as variability in crop yields. Unexpectedly large crops pressure both systems.

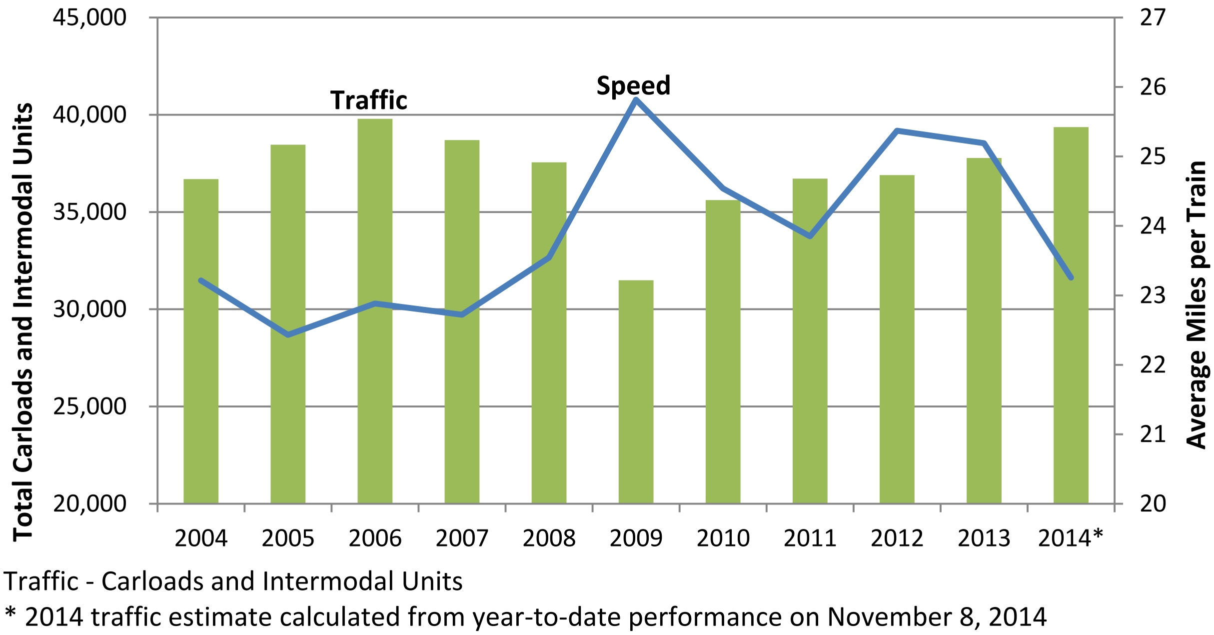
The 2013/14 harvest posed additional challenges beyond the unexpectedly large volume of grains and oilseeds needing to be stored or moved during a relatively short period. Producers, shippers, and transportation providers attempted to plan for the fall peak based on available information, but unpredictable weather ultimately dictated the length and timing of the growing and harvest seasons as well as production volume. The size of the combined 2013/14 harvest for corn, soybeans, and wheat set a new production record at over 19 billion bushels, led by a record corn harvest at almost 14 billion bushels. Moreover, the size of the crop was unexpected as early assessments projected smaller yields because of late planting due to rain delays in the Spring. Yet, favorable weather and a later-than-usual frost extended the growing season into October, allowing the corn crop to reach full maturity, particularly in the northern states. However, the late maturity of the crops compressed the harvest window, narrowing the window of opportunity to move the larger supply of grains and oilseeds, particularly in time to capture relatively high prices for export sales at the ports. Timeliness is particularly important for U.S. soybean exports, which compete with the South American soybean harvest that begins the following spring.

Rail Capacity Limitations

The short-term ability of railroads to provide service to shippers has been partially compromised by their own success through growing traffic volumes. Higher traffic volumes can indicate a more efficient utilization of the existing rail network, but they can also signal potential congestion as capacity utilization rates rise. When juxtaposed against average train speed, that distinction is a good indicator for the presence of congestion (see figure 3).

Due to diminishing returns, at some point, the addition of more carload traffic to the rail lines will reduce network efficiency unless there is a simultaneous improvement in operational fluidity or physical expansion of network capacity. Recognizing a need to expand its capacity to keep up with long run traffic growth, BNSF undertook a $1 billion investment project in 2014 to add rail capacity across its Northern Corridor (including $400 million in ND, $235 million in WA, $160 million in MT, $150 million in IL, and $120 million in MN) where much of the oil and grain production that travels across its network originates. Projects include building 50 miles of a second mainline track and replacing 110 miles of track in North Dakota in 2014; and building a second mainline track between Spokane and Vancouver and replacing 60 miles of track in Washington in 2015. Unfortunately, the benefits stemming from the planning for and executing of such plans can take 6-12 months to materialize and can exacerbate short run system disruptions. For example, BNSF had to shut down traffic lanes for 10-12 hours per day while track work was undertaken to build the additional 50 miles of mainline track in 2014. Delays may occur in 2015 as BNSF builds the second mainline track of 60 miles in Washington State. Ultimately, such action will improve network performance, but in 2013 and 2014, it had the immediate impact of further decreasing network capacity and increasing congestion.

Figure 3: Class I Traffic Volume and Train Speed



Source: AMS Analysis of Association of American Railroads, *Weekly Railroad Traffic*; *Railroad Performance Measures*; Surface Transportation Board, *Quarterly Freight Commodity Statistics*

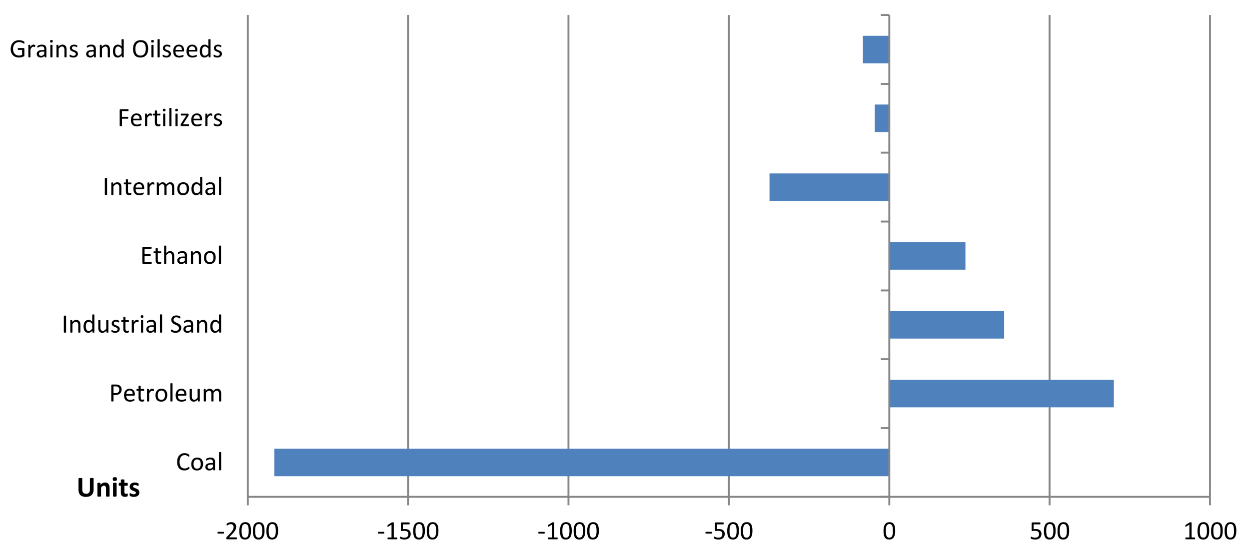
Increase and Changing Mixture of Rail Traffic

After experiencing several years of steady growth, annual Class I carload and intermodal traffic reached a peak in 2006. As traffic volumes increased, average train speed fell across the network due to increasing congestion. During the following years of the economic recession, rail traffic fell as a result of declining economic activity. In 2009, rail traffic was only 79 percent of the peak achieved in 2006. On the other hand, decreasing traffic volumes created additional capacity and helped relieve some congestion across the network. Average train speed improved as a result of the decline in traffic volume, with train speed reaching a peak in 2009, the same year traffic volume was lowest in recent times (Figure 3).

As the economy has continued to recover, annual rail traffic has almost returned to its prerecession peak, with traffic at 95 percent of the peak in 2013 and at an estimated 99 percent in 2014. The rail network appeared capable of handling that additional growth between 2010 and 2013 with only some loss in train speed in 2010 and 2011. However, the sharp decline in train speed during 2014 indicates the additional traffic growth was partially responsible for causing increased congestion across the network.

In addition to traffic growth, the compositional change in commodity traffic since 2006 is also contributing to network congestion. Much of the new traffic growth since 2006 has been in different commodities than those which saw a decline with the recession. The increased carloads of commodities, such as petroleum, industrial sand, and ethanol require different train types and service than those that declined with the recession. As such, transitional changes related to the new traffic composition further reduce network capacity in the interim. That new traffic composition has led to excess capacity in some regions where traffic volume has declined, such as for coal shipments from the Powder River Basin. The change, however, has led to insufficient capacity in other areas where new traffic growth has occurred, such as crude oil shipments around the Bakken Shale Formation and fracking sand production in areas of the Midwest (see figure 4).

Figure 4: Change in Class I Carloads from Peak (2006 – 2013)



Source: AMS Analysis of Surface Transportation Board *Quarterly Freight Commodity Statistics*

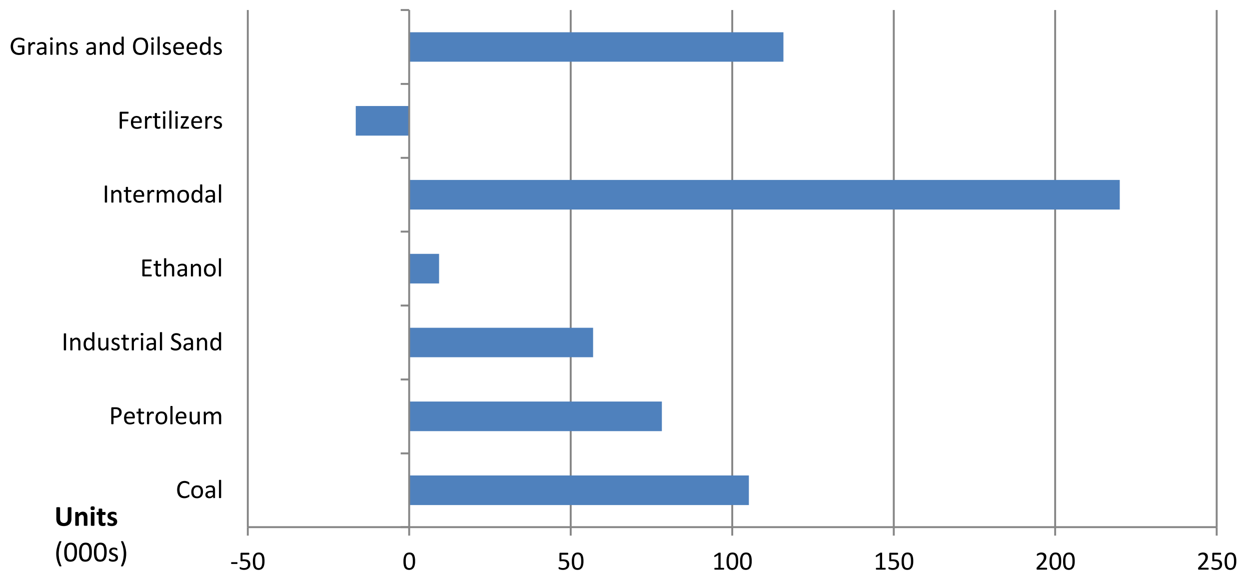
Shipments of shale oil and fracking sand in the Dakotas are up significantly. A recent GAO study concluded that oil shipments by rail have increased 3,000 percent since 2007, although still representing less than 1 percent of total carloads.[9] That has added additional congestion on the rail lines in those States, slowing the shipments of grain.

Nevertheless, a recent resurgence in coal shipments during 2013 and continued strong growth in intermodal shipments since the recession further show how rail traffic responds to the larger economic forces stimulating demand for rail service (see figure 5). However, even though grains and oilseeds, intermodal, coal, petroleum, and industrial sand traffic grew, fertilizer shipments in the first half of 2014 decreased, as compared to the first half of 2013. Similar to grains and other commodities, deliveries of fertilizer—a very important agricultural input for planting—were delayed by rail service problems in the latter half of 2013 through the first half of 2014. Shippers and producers expressed their concerns over fertilizer shipment problems by rail,

[9] GAO, Freight Transportation: Developing National Strategy Would Benefit from Added Focus on Community Congestion Impacts, GAO-14-740 (Washington, D.C.: Sep. 19, 2014).

prompting the Surface Transportation Board to issue an order in April 2014, for BNSF and CP to publish their plans to ensure adequate delivery of fertilizer in order to meet spring planting of U.S. crops.

Figure 5: Change in Class I Traffic (first-half 2014 vs. first-half 2013)



Source: AMS Analysis of Surface Transportation Board *Quarterly Freight Commodity Statistics*

Because BNSF and CP were the two railroads experiencing the most acute service problems, quarterly changes in commodities on those two railroads highlight operational problems and also show how decreases in specific commodities were offset by increases in others (see tables 1 and 2). Shown by the change in cars handled for all commodities, BNSF traffic growth slowed in the 1st quarter of 2014 due to operational problems, mostly due to the severe winter. However, operational problems on CP started earlier in the 3rd quarter of 2013 and lasted through the 2nd quarter of 2014. For BNSF, consistent declines occurred for grain carloads between the 1st quarter of 2012 and 3rd quarter of 2013 and throughout for fertilizer except for the 4th quarter of 2012, 1st quarter of 2013, and 2nd quarter of 2014.

The lower-than-expected growth in BNSF's grain carloads beginning in the 4th quarter of 2013 given the record harvest and previous year's drought-impacted harvest shows how operational problems were negatively impacting its grain traffic. Much of that loss in market share of the 2013/14 harvest was gained by other rail carriers. While other commodities also experienced periods of growth and decline, only crude oil and hydraulic fracking sand experienced uninterrupted growth throughout the period (see table 1).

On CP, beginning in the 3rd quarter of 2013, consistent declines occurred for grain carloads over three quarters and for fertilizer carloads for four quarters. Similar to BNSF, only crude oil experienced uninterrupted growth throughout the period (see table 2). In contrast to BNSF, which began recovering coal traffic in the 2nd quarter of 2013, CP's coal traffic steadily declined beginning in the 2nd quarter of 2012 through the 2nd quarter of 2014.

Table 1: Increase in Total Cars Year-over-Year (BNSF)

	Coal	Crude Oil	Frac Sand	Intermodal	Grain	Fertilizers	Ethanol	All Commod.
1Q12	(23,409)	13,993	7,057	24,306	(2,010)	(1,677)	(607)	74,578
2Q12	(51,896)	24,718	3,775	9,016	(15,494)	(767)	(1,685)	37,839
3Q12	25,210	36,450	2,865	(16,608)	(6,510)	(790)	(3,128)	127,108
4Q12	(82,712)	46,814	1,765	(20,639)	(24,248)	50	(4,014)	(33,338)
1Q13	(17,867)	50,451	2,048	10,840	(22,144)	1,042	(1,799)	73,896
2Q13	30,088	49,949	4,197	3,511	(28,446)	(827)	362	88,375
3Q13	29,751	30,550	5,913	39,855	(2,988)	(757)	2,047	130,552
4Q13	14,195	29,738	3,912	52,963	16,050	(735)	2,053	139,626
1Q14	19,878	18,390	579	(2,515)	5,437	(2,307)	2,260	22,833
2Q14	30,275	11,650	6,451	12,168	23,699	241	1,367	116,069

Source: Surface Transportation Board, *Quarterly Freight Commodity Statistics*

Table 2: Increase in Total Cars Year-over-Year (CP)

	Coal	Crude Oil	Frac Sand	Intermodal	Grain	Fertilizers	Ethanol	All Commod.
1Q12	5,875	6,368	579	5,285	(3,848)	744	(660)	20,855
2Q12	(1,658)	10,443	132	(52)	(12,946)	679	(185)	975
3Q12	(4,547)	11,320	(174)	1,545	1,170	780	(1,912)	13,332
4Q12	(1,519)	8,527	(1,441)	1,229	6,997	1,794	81	17,747
1Q13	(3,530)	10,829	953	(794)	5,710	1,200	316	7,898
2Q13	(5,048)	7,044	2,872	3,522	7,028	845	(146)	13,916
3Q13	(3,645)	1,915	3,662	4,029	(2,854)	(696)	570	791
4Q13	(5,645)	8,991	3,919	2,211	(6,319)	(1,870)	3	(1,477)
1Q14	(3,258)	1,281	6,056	(688)	(8,817)	(1,506)	(2,607)	(23,370)
2Q14	(1,634)	2,833	7,089	(7)	1,546	(1,595)	(2,331)	3,088

Source: Surface Transportation Board, *Quarterly Freight Commodity Statistics*

Severe Winter and Chicago Bottlenecks

On April 10, 2014, the Surface Transportation Board held a public hearing to address rail service issues. During the hearing, the railroads reported that the unusually harsh winter had diminished their ability to keep the system fluid leading to a reduction in rail capacity and a backlog of railcar deliveries. That was especially true in the northern tier of the United States in Chicago and areas of operations emanating both east and west of that major rail hub. Amidst growing traffic volume, the extreme cold forced the railroads to reduce train lengths by half in order to maintain operability of the pneumatic braking systems and maintain safe operations. That operational change had the effect of reducing capacity on those segments by half, if not more, and also diminished asset utilization. Reducing train lengths requires more locomotives and additional crews to run the same number of cars (i.e., meet current demand). But track capacity is also constrained by the number of trains that can occupy segments of the track at any one time. Since railroading is a network industry, that reduction in operations eventually cascades throughout the system. In that situation, Chicago, the largest North American rail interchange point, was a significant chokepoint.

Chicago is the busiest rail hub in the United States, but for many years has been adversely affected by chronic rail congestion and long interchange times between railroads. Six of the seven largest railroads in the United States switch cargo in Chicago. More railroad tracks originate from Chicago than any other city in the United States. Roughly a quarter of all rail traffic passes through Chicago, including most cross-country traffic.

Chicago is a particularly important interchange point for rail grain traffic from one railroad to another and is a major distribution center for grain movements. Chicago and the surrounding counties are one of the top five regions in grain elevator capacity in the nation due to the region's central location between the farm belt and consumption areas and proximity to the Mississippi River for delivery to export ports. In addition, one of the Nation's largest grain trading markets is located in Chicago.

Most of the grain passing through Chicago is corn and wheat based on its proximity to corn and wheat fields. A large amount of grain is brought into Chicago area elevators by truck and then loaded onto trains for shipment.[10] The most common destinations from Chicago are California and Texas port regions for grain destined for export market and feedlots, the Northeast region for milling plants, and the Illinois River for barge loading to Louisiana and the Mississippi Gulf export market.

Chicago has been the focus of major public and private infrastructure investments to improve the flow of traffic in and out of that gateway. The CREATE Project (Chicago Region Environmental and Transportation Efficiency Program) is an ongoing private-public partnership multiyear/multibillion dollar project that aims to increase the efficiency of passenger and freight rail infrastructure.

Rail Congestion

Each of the seven Class I freight railroads operating in the United States have experienced declining performance metrics over the past year. In early 2014, the Class I railroad weekly performance measures declined significantly. System speeds began to fall and the number of shipper complaints regarding poor service rose. By the end of March (week 13), system speeds among the major carriers continued to fall and shipper complaints increased to the point where the Surface Transportation Board announced that it would hold a hearing to assess rail service issues.

When conditions on a railroad cause operating performance to erode, traffic cannot enter and exit the system efficiently—rail speeds may slow, terminal dwell times may increase, and those problems may spill-over to other regions. Because railroading is a network industry, other carriers that may not be experiencing performance problems will continue to originate traffic

[10] U.S. Department of Agriculture, Agricultural Marketing Service. *Grain Transportation Report.* July 10, 2014. Web: http://dx.doi.org/10.9752/TS056.07-10-2014

destined for interchange with the carrier experiencing service issues. At those interchange points, railcars may sit in yards because of degradation in rail service. It is from those points where service issues cascade, causing carriers with no problems to begin experiencing declining service metrics across their respective networks. Diminishing speeds on one railroad also play a role in affecting other railroad performance metrics. Those include cars on line and terminal dwell time. When carriers are unable to move cars on line efficiently, the number of cars in transit increases, saturating the network and causing further speed reductions on the network. Similarly, when railcars enter yards or terminals and are unable to exit due to saturation, terminal dwell times increase. In essence, given a fixed amount of transported products, system speed can be used as an indicator of how efficient the system is operating and how well the railroads are able to meet their customer demands. Obviously higher or lower volumes of goods transported over rail will affect dwell times and speeds.

In the recent service decline when the rail system has been operating at a high level of capacity, an individual railroad's system speed, terminal dwell time, and cars on line have been key indicators regarding how well the railroad is performing versus its performance in previous years.[11] Velocity, measured in miles per hour (mph), during 2013 compared to 2012 for the major U.S. railroads were:

- BNSF train speed fell from 23.7 mph to 21.5 mph;
- UP train speed fell from 27.6 mph to 23.5 mph;
- CSX train speed fell from 24 mph at the beginning of the period to 20.4 mph in week 13;
- NS train speed was basically flat for that period, except for their most significant speed degradation occurring September through mid-October (week 35 through week 42); and
- KCS also experienced speed degradation as well as the Canadian railroads and their U.S. operations. CN speeds have been trending upward and are now at their 2012/2013 levels.

Effects of Rail Service Problems

Due to the issues discussed above, rail carriers were unable to meet all shipper demand in early 2014 and were forced to delay delivery for many shipments. A combination of reduced rail capacity and strong demand for rail transport constrained the availability of grain cars for shipment. As service continued to deteriorate, the growing imbalance between railcar supply and demand manifested as backlogged grain shipments and higher-than-average prices for empty grain cars sold in the primary and secondary auction markets.[12] Many shippers unable to pay the

[11] According to the Association of American Railroads, cars on line is the average of the daily on-line inventory of freight cars. Terminal Dwell is the average time a car resides at the specified terminal location expressed in hours. The measurement begins with a customer release, received interchange, or train arrival event and ends with a customer placement (actual or constructive), delivered or offered in interchange, or train departure event.

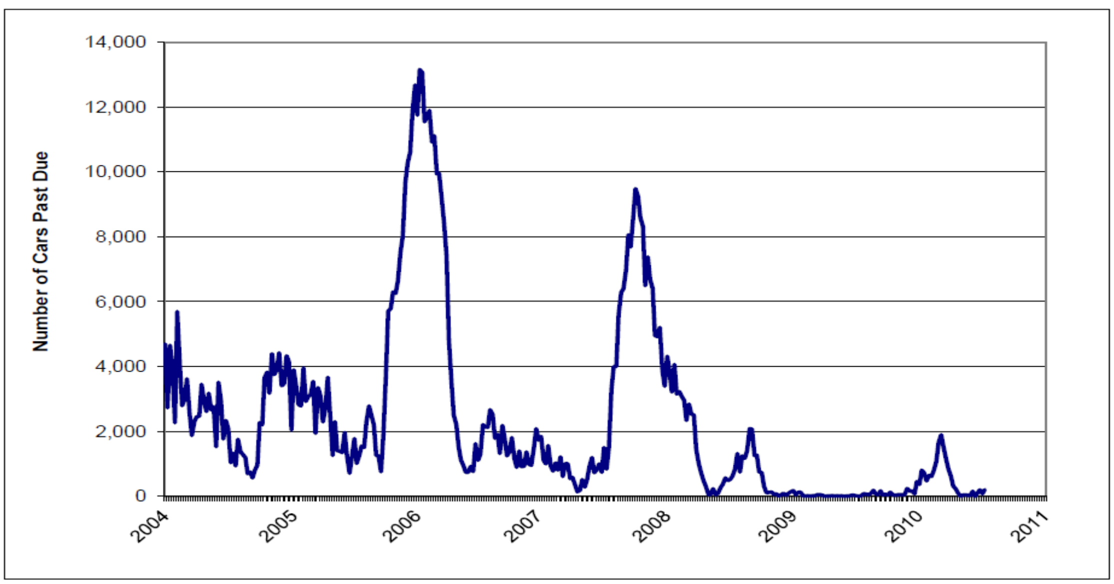
[12] BNSF and UP offer various forward-guaranteed railcar service contracts for grain shipping. Shippers bid upon those service contracts in auctions and purchase them directly from the rail carriers in the primary market. Shippers may later trade those contracts among themselves through bidding in auctions known as the secondary market.

additional premiums for service diverted more grain into storage or used alternative transportation modes such as a competing rail carrier, truck, or barge where available – all at a higher-than-normal cost. Each of those effects is discussed more thoroughly in the following sections.

Grain Car Backlog

In the past, railcar service for grain transport has shown delays, typically as a result of adverse weather conditions, during periods of unusually high levels of grain and oilseed exports, and/or above-average harvests. While some backlog is normal following harvest (see figure 6), the levels reached by BNSF and CP over the course of last year were reflective of much more significant problems. The combination of high demand for rail service across multiple commodity sectors and the reduction in rail capacity due to the severe winter diminished BNSF and CP's performance, with service unable to stay abreast of demand. The quantity of grain shipments transported by rail continued to lag further and further behind demand over the months following the 2013 harvest. At the height of the backlog on March 28, 2014, BNSF had 16,112 grain cars past due (defined as being greater than 3 days past the want date), with the largest concentration of past-due grain cars in North Dakota, South Dakota, Montana, and Minnesota. Although reliable CP data were not available at the time, shipper complaints indicated a similar problem in the same States serviced by CP.

Figure 6: BNSF Historic Backlog of Grain Cars



Source: Figure 2.1.7 from Wilson and Dahl (2010)

Where available, grain shippers with alternatives to BNSF and CP used alternative railroads, barges, or truck to move their grain. But in the most affected regions of those 4 States, shippers were heavily dependent on BNSF and CP to move the record harvest. The decline in service led to large backlogs of grain shipments, with grain in some areas simply unable to be shipped, forcing producers to place grain in temporary and emergency storage.[13]

The amount of grain moved by each railroad over the past marketing year for CSX, NS, KCS, and UP was greater than in the past several years (see tables 3 and 4). During 2013/14, although still the predominant grain hauling railroad, BNSF moved the lowest amount of grain of any previous year. That shift from BNSF to the other railroads shows how rail service problems on BNSF likely led to a diversion of grain traffic from BNSF to other rail carriers given the record 2013/14 grain harvest. U.S. grain movements over CN and CP are not available because the reported numbers contain all of CN and CP's grain traffic, most of which moves in Canada and is subject to prescribed weekly movements under a Canadian order until the end of March 2015, at the earliest.

Table 3: Comparison of Railroad Grain Movements for BNSF, CN, CP, and all U.S. Railroads

Period (Oct. through Sep.)	BNSF Carloads	Surplus / (Deficit) 2013 to period	CN Carloads	Surplus / (Deficit) 2013 to period	CP Carloads	Surplus / (Deficit) 2013 to period	U.S. Railroad Carloads	Surplus / (Deficit) 2013 to period
2007-2008	585,305	(127,566)	233,999	23	254,994	22,742	1,267,639	(216,184)
2008-2009	489,829	(32,090)	211,075	22,947	291,237	(13,501)	1,037,896	13,559
2009-2010	532,879	(75,140)	199,255	34,767	269,064	8,672	1,133,019	(81,564)
2010-2011	558,592	(100,853)	201,041	32,981	261,473	16,263	1,155,018	(103,563)
2011-2012	517,030	(59,291)	202,323	31,699	260,826	16,910	1,047,071	4,384
2012-2013	468,961	(11,222)	181,181	52,841	276,758	978	902,966	148,489
2013-2014	457,739	-	234,022	-	277,736	-	1,051,455	-
prior 5-year avg	513,458	(55,719)	198,975	35,047	271,872	5,864	1,055,194	(3,739)

Source: Association of American Railroads, Weekly Rail Traffic

Table 4: Comparison of Railroad Grain Movements for CSX, NS, KCS, and UP

Period (Oct. through Sep.)	CSX Carloads	Surplus / (Deficit) 2013 to period	NS Carloads	Surplus / (Deficit) 2013 to period	KCS Carloads	Surplus / (Deficit) 2013 to period	UP Carloads	Surplus / (Deficit) 2013 to period
2007-2008	146,501	(44,894)	164,140	(7,458)	36,064	10,622	335,629	(46,888)
2008-2009	107,970	(6,363)	142,503	14,179	36,744	9,942	260,850	27,891
2009-2010	110,586	(8,979)	158,269	(1,587)	37,954	8,732	293,331	(4,590)
2010-2011	99,215	2,392	154,331	2,351	35,967	10,719	306,913	(18,172)
2011-2012	93,776	7,831	147,075	9,607	27,685	19,001	261,505	27,236
2012-2013	76,291	25,316	128,369	28,313	28,726	17,960	200,619	88,122
2013-2014	101,607	-	156,682	-	46,686	-	288,741	-
prior 5-year avg	97,568	4,039	146,109	10,573	33,415	13,271	264,644	24,097

Source: Association of American Railroads, Weekly Rail Traffic

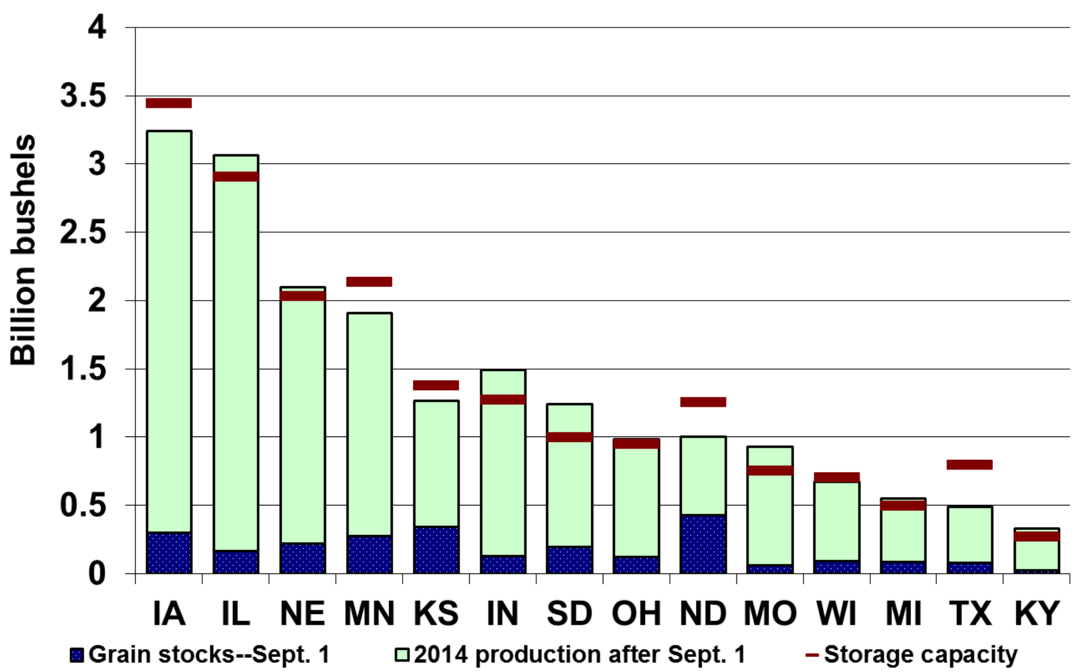
[13] U.S. Department of Agriculture, Agricultural Marketing Service. *Grain Transportation Report.* October 31, 2013. Web: http://dx.doi.org/10.9752/TS056.10-31-2013

Storage Constraints

Poor rail performance following the 2013/14 record harvest prevented grain and oilseed in some areas from being transported. Falling export demand for corn over this period also limited the amount of grain transported. On September 1, 2014, remaining grain and oilseed stocks in storage were up to 40 percent higher than in previous years in some of the major grain producing States most impacted by poor rail performance in the previous year. That situation left less permanent storage available to accommodate another record harvest.

The volume of grain and oilseed production and stocks was estimated to have exceeded permanent grain and oilseed storage capacity during the 2014/15 harvest season by 952 million bushels, or about 5 percent of the harvest (see figure 7). Those levels of storage capacity shortage are higher than any year since 2010, which had an estimated 805 million bushel shortfall in permanent storage capacity distributed throughout the top 14 grain-producing States.

Figure 7: Grain Production, Stocks, and Storage



Source: AMS Analysis of USDA *Crop Production*, Oct. 10, 2014; *Grain Stocks*, Sep. 1, 2014.

Under its United States Warehouse Act authorities, USDA allows emergency and temporary storage of grain to mitigate storage shortfalls, but the entity storing that grain is still responsible for the quantity and quality of the grain. Following the 2014/15 harvest, an increasing amount of grain storage warehouses have sought approval for emergency or temporary storage. The approvals will allow grain storage operators to store corn, wheat, sorghum, and other grains on the ground until warehouse space is made available. However, losses in grain stored on the ground and in temporary systems are likely higher than permanent storage, resulting in higher storage costs and lower elevator bids to the farmer.

USDA Farm Service Agency's Commodity Operations Warehouse License and Examination Division has received about a 20 percent increase in requests for emergency ground storage compared to previous years, with requests coming from 29 States. Current ground storage requests have totaled 370 million bushels, but are expected to reach 400 million bushels for the 2014/15 harvest. That quantity is the equivalent of 100,000 jumbo covered-hopper railcars, 7,619 barges, or 439,560 truckloads.

Primary and Secondary Railcar Markets

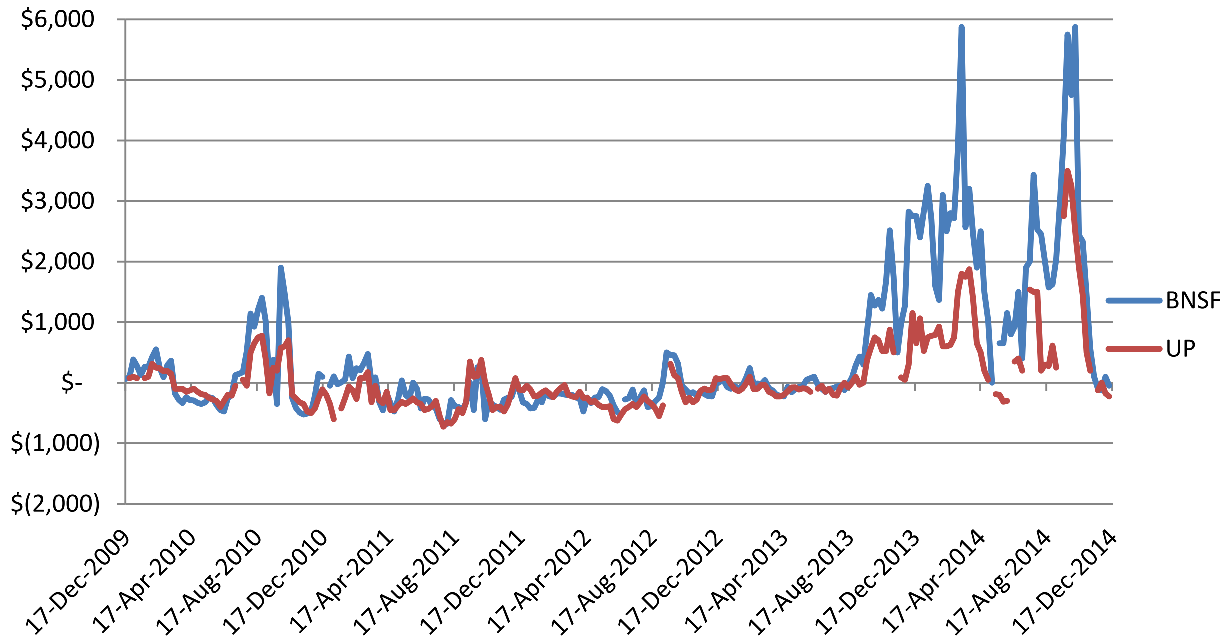
Shippers have the option of shipping grain by rail through either purchasing service at the tariff rate or, if using BNSF or UP, through paying an additional premium for a contract guaranteeing delivery of empty railcars. In both cases, shippers will also pay any underlying fuel surcharges. BNSF and UP offer a set amount of those contracts each month, which guarantee delivery of grain cars within a specified window. Shippers purchase those contracts directly from rail carriers in the primary market and may later trade them in a secondary market among themselves to reallocate the service as needed.

Many grain shippers, along with other users of rail services, found it necessary to pay the additional premiums for guaranteed railcar delivery amidst declining rail service and growing backlogs because of delivery obligations and lack of storage. Those factors substantially increased the price of railcars on the primary and secondary grain car markets. Secondary railcar market prices reached historic highs throughout the past year (see figure 8). Normally, the price of those contracts represents only a very small fraction of the overall cost of shipping grain by rail (along with the tariff rate and fuel surcharge), but they became so high at times during 2013 and 2014 that they doubled the cost of shipping grain by rail on specific routes for those that had to purchase railcars on the secondary market. That situation added as much as $1.50 per bushel to the cost of shipping grain by rail, which was captured by the sellers of railcar capacity in the secondary market; i.e., not the railroad companies.

Shippers typically purchase those contracts in the primary market with little to no premium above the tariff rate and later resell them in the secondary market at either a small premium or loss. As a tool for hedging transportation cost risk, those premiums and losses have averaged out close to zero over time (shown in the period between December 2009 and December 2013 in Figure 8). But as early as May of 2014, shippers were already paying record high premiums in the primary market (between $500 and $1,500 per car) to secure guaranteed delivery during September, October, and November. Between July and October, remaining contracts for those same months were being purchased in excess of $3,000 per car in the primary market.

Such high bids in the primary railcar market are a stark contrast to the previous 10 years, when bids have rarely exceeded $700 per car. The high premiums indicate insufficient rail capacity relative to demand but are also a reflection of how shippers became increasingly worried about a repeat of the 2013/14 rail service problems during the 2014/15 harvest.

Figure 8: Average Secondary Railcar Shuttle Market Bids per Car



Source: AMS Analysis of USDA *Grain Transportation Report* data

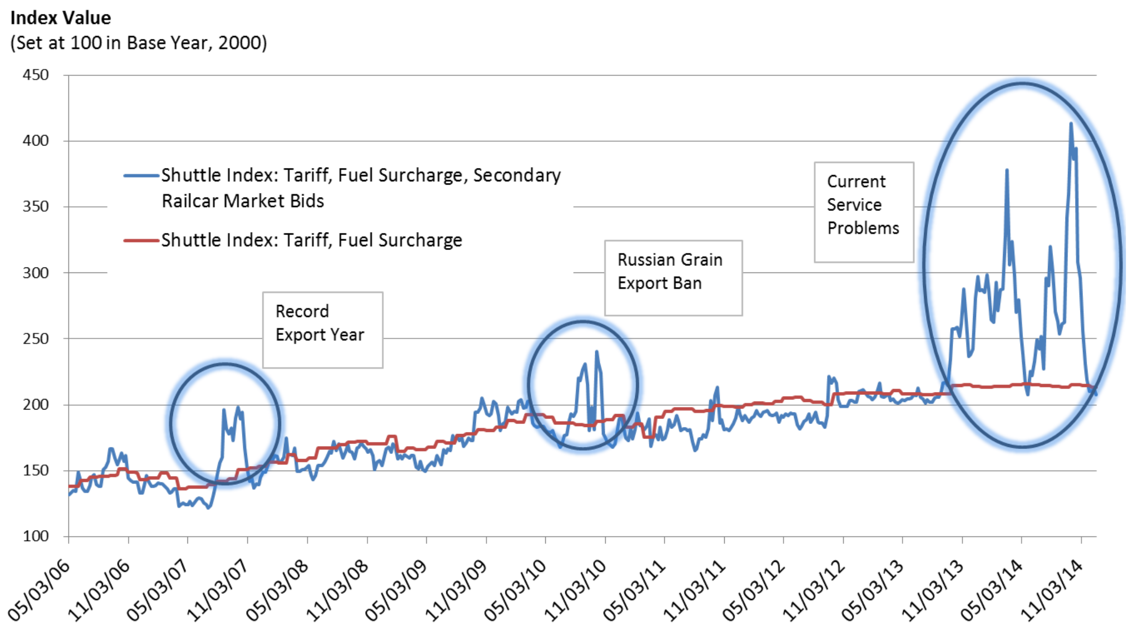
Average bids in the secondary rail market reached a record high of $5,875 per car for BNSF shuttle service both in March and October 2014, with bids averaging between $2,000 and $3,000 in between. Those premiums represent an additional cost, which has persisted over the past year and added substantially to the overall cost of shipping grain by rail. That is in contrast to previous years when bids usually traded either at a premium or loss within $1,000 of the tariff rate, only reaching the $2,000 to $3,000 range on rare occasions.

Paying additional premiums for guaranteed service delivery is a common practice in any given year, especially following a large harvest or with unexpected shifts in supply and demand for rail service. However, the past year's rail service disruptions have extended and intensified that practice. Instead of being the exception, it became the norm. In typical years with above-normal demand for rail service, agricultural shippers only paid additional premiums through the secondary railcar market for about 20 weeks until supply and demand became rebalanced. In contrast, shippers have paid record high premiums, 28 to 150 percent above previous levels on average, for about 65 consecutive weeks. For those shippers using the secondary railcar market, that has had the effect of inflating the cost of shipping grain by rail.[14]

When the supply of rail service meets expected demand for rail service, bids in the secondary railcar market (price paid over the original primary market price paid) will be close to zero (blue line and red line trend together) (Figure 9). However, when there are unexpected service disruptions, limiting the supply of rail service, or unexpected increases in demand such as large export demand or large crop yields, bids in the secondary railcar market increase.

Plotting an index of the overall cost of shipping grain by rail (blue line) against an index of the tariff rate and fuel surcharge (red line) shows how shifts in expected supply and expected demand can result in increased transportation costs (see figure 9). Comparing the magnitude and duration of recent unexpected shifts in supply and demand for shuttle service with this past year's rail service problems shows the 2014 rail service problems have had the greatest impact on the cost of shipping grain by rail of any recent events in both duration and magnitude.

Figure 9: Secondary Railcar Market Effect on Rail Shuttle Costs



Source: AMS Analysis of USDA *Grain Transportation Report*, Grain Transport Cost Indicators

[14] It is not possible for USDA to accurately quantify how much those additional costs have been in total due to the unavailability of data concerning those contracts. The costs of those contracts are known, but the details and extent of those contracts is private. Therefore, USDA has no way of accounting for any reselling of contracts or the volume of sales in the primary and secondary markets. Both of those components are critical information needed to evaluate the total amount of additional costs those contracts have added to shipping grain by rail.

Since November 2014, bids in the secondary railcar market have fallen back into an expected range given the improved performance of railroads in moving the 2014/15 harvest. Nevertheless, it is uncertain how another severe winter would impact rail performance and the prices of those guaranteed service contracts in the secondary market. Given that the rail industry is operating near full capacity (overall rail shipments in 2014 are expected to exceed the previous record set in 2006 for traffic volume) small unexpected shocks in supply of rail service or demand for those services can translate into relatively large movements in the secondary auction market.[15] Premiums spiked and dipped numerous times in 2014 as circumstances changed. Grain market signals indicate that soybean export demand could continue into 2015 and demand for shipping corn to foreign destinations could also increase in the spring.

Fertilizer

Fertilizer moves as either liquid or dry bulk through an interconnected system of rail, barge, truck, pipeline, and ocean carrier. Railroads typically haul the majority of fertilizer ton-miles (36 percent), making them the predominant mode for long distance movements.[16] Trucks haul the majority of the total tonnage (65 percent), mainly for short haul movements, followed by rail with 19 percent, multimodal with 11 percent, pipeline with 3 percent, and barge with 2 percent.

Domestically-produced fertilizers are usually railed from the origination plant to larger distribution centers. They may be delivered by truck directly to end users or sent to smaller cooperatives for sale to local farmers. Imported fertilizers and raw materials enter the United States by truck or rail from Canada and Mexico and by vessel up the Mississippi from the Gulf of Mexico. Further, two ammonia pipelines in the United States help safely distribute ammonia from production sites to manufacturing plants. One pipeline runs from the Texas production area into Minnesota and the other from the Louisiana production area to Nebraska and Indiana. Nitrogen fertilizer production areas are both destinations for imported raw materials and points of departure for fertilizer exports. Phosphate and potash are tied to mining operations, so those materials are typically moved by rail or truck to export destinations.

New Orleans serves as an important hub for receiving domestic production shipped through the Gulf and foreign imports arriving by ocean carrier and for originating domestic movements by barge and rail. About 50 percent of urea imports—the primary nitrogen dry bulk fertilizer—arrive through New Orleans. Barges play a critical link in moving fertilizer from New Orleans to inland distribution points, primarily on the Upper Mississippi River (above St. Louis), but also to the Ohio, Arkansas, Illinois, and the Lower Mississippi River.

---

[15] Preliminary data from the Association of American Railroads, *Weekly Railroad Traffic* report show that total carload and intermodal traffic on U.S. and Canadian railroads through Week 50 of 2014 is 4 percent greater than during the same period in 2006, which was a peak year for the amount of railroad traffic.

[16] U.S. DOT Bureau of Transportation Statistics and U.S. Census Bureau, 2007 Commodity Flow Survey. (Multimodal indicates a combination of truck and rail, truck and barge, rail and barge, or another combination.)

Nitrogen is one of three primary nutrients—along with phosphates and potash—in commercial fertilizers. In 2011, more than 54 percent of the nitrogen and 85 percent of the potash used for fertilizer in the United States came from imports. In contrast, the phosphate supply mainly depends on domestic production.[17] Phosphate and potash are mined, limiting fertilizer production to ore-rich areas. The raw materials for phosphate fertilizer are phosphate rock and sulfur. Those reserves are found in 13 States and are mined at 30 locations. Potash ore is mined and extracted in 6 locations from three States (see figure 10).[18]

Recent fertilizer production facility construction plans may improve the supply of nitrogen-based fertilizers in the Midwest, reducing the dependency on and setbacks that can occur from the long-haul transportation of critical fertilizer deliveries. Currently, nitrogen fertilizer (such as urea and ammonia) is produced at 70 locations in 28 States.[19] However, the recent abundance and lower domestic natural gas prices have spurred investment in nitrogen production. By the end of 2013, six ammonia plants were under construction and eight more were planned.[20] Those new plants, combined with the reopening of two inoperative ammonia plants, could increase the production of ammonia in the United States by 54 percent within 5 years. Similarly, U.S. urea production could increase by 73 percent.[21]

As of September 2014, a new nitrogen fertilizer plant has been planned for construction in North Dakota, with a scheduled opening in 2018. The plant will be located close to abundant natural gas supplies, which are a primary input of nitrogen fertilizer production, and will reduce the need for long-haul barge and truck shipments from the Gulf States and Oklahoma where most nitrogen fertilizer is produced (see figure 10), potentially reducing fertilizer prices to users. The plant will supply nitrogen to North Dakota, Minnesota, South Dakota, Montana, and Canada.

For the fertilizer year ending June 30, 2012, the most recent year with available data, United States farmers used 13.5 million nutrient tons of nitrogen fertilizer, 4.6 million nutrient tons of potash, and about 4.4 million nutrient tons of phosphate. The 2012 total fertilizer use of 22.5 million nutrient tons was 7.6 percent higher than in 2010. Increases in planted acreage and higher commodity prices, which encouraged farmers to increase crop yields, drove the increase in consumption.

---

[17] USDA, Economic Research Service, http://www.ers.usda.gov/topics/farm-practices-management/chemical inputs.aspx .

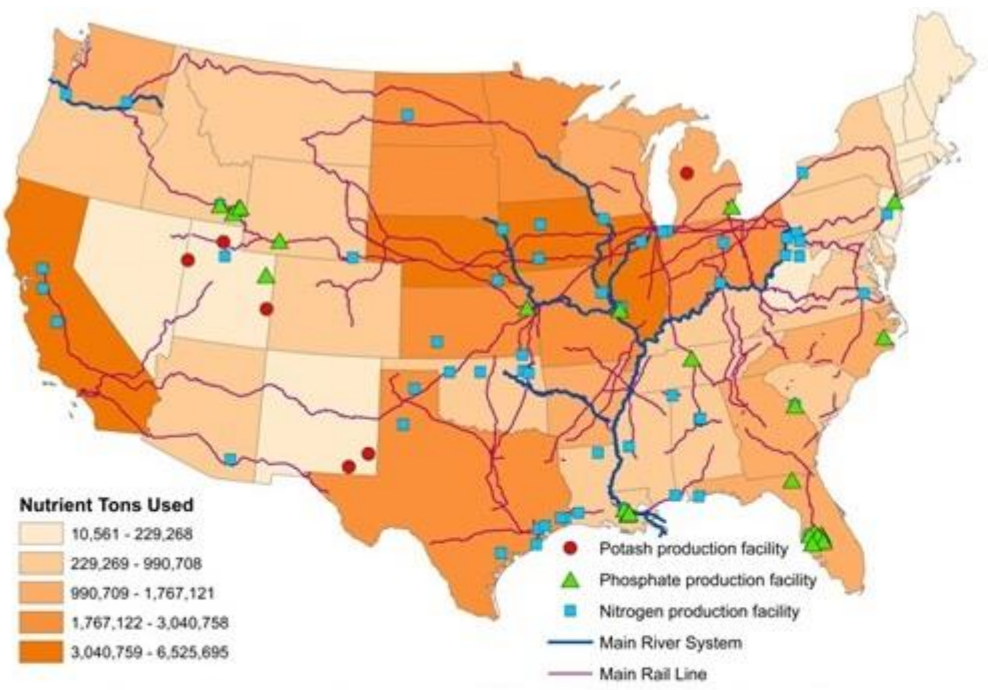
[18] USDA, Economic Research Service, http://www.ers.usda.gov/topics/farm-practices-management/chemical-inputs.aspx .

[19] International Fertilizer Development Center, *North America Fertilizer Capacity, March 2014.* www.ifdc.org/Media Center/Publications/IFDC Publications/Fertilizer Market-Related Reports.

[20] International Fertilizer Development Center, *North America Fertilizer Capacity, March 2014.* www.ifdc.org/Media Center/Publications/IFDC Publications/Fertilizer Market-Related Reports.

[21] International Fertilizer Development Center, *North America Fertilizer Capacity, March 2014.* www.ifdc.org/Media Center/Publications/IFDC Publications/Fertilizer Market-Related Reports.

Figure 10: Fertilizer Production Facilities and Nutrient Use (year ending June 30, 2012)



Source: AMS Analysis of Association of American Plant Food Control Officials, *Commercial Fertilizers, 2011;* International Fertilizer Development Center, *North America Fertilizer Capacity, 2012*.

Barge and rail movements of fertilizer during the first quarter of 2014 experienced setbacks due to extreme winter conditions. In addition, widespread and ongoing service issues on the rail network since October 2013 affected rail shipments of fertilizer. Fertilizer shipments by rail (carloads terminated) between July 2013 and June 2014 were 4 percent behind the prior 3-year average (see tables 5 and 6). Fertilizer demand is typically driven by corn planted acreage. Fertilizer sales fell in 2008/09, including both imports and exports of fertilizer, but increased over the subsequent 4 years. Yet, fertilizer shipments were lower for almost all of the railroads in 2013/14 compared to the previous year. Fertilizer shippers located on BNSF and CP lines experienced significant delays in receiving car orders to ship fertilizer while customers experienced significant delays in receiving previously ordered carloads. Many of those customers were unable to receive fertilizer by alternative transportation options.

Those issues were raised by shippers at an April 10, 2014, STB hearing, explaining the critical window for receiving fertilizer shipments in time for application during spring planting. As a result, the STB ordered BNSF and CP to report their plans for meeting fertilizer delivery needs. That action focused attention on the situation, whereby the railroads committed additional resources to ensure fertilizer deliveries were made on time. BNSF identified that it needed to move an additional 52 trainloads of fertilizer to meet customer needs and accomplished that through several measures including adding 110 jumbo hopper cars to the existing fertilizer fleet and creating fertilizer shuttle trains. CP committed an additional train pair between the United

States and Canada to support both grain and fertilizer shipments. Cold, wet weather also delayed the start of planting in some areas, providing additional time for the railroads to catch up on delayed shipments.

Table 5: Comparison of Railroad Fertilizer Movements for BNSF, CN, CP, and all U.S. Railroads

Period (Q3 through Q2)	BNSF Carloads Terminated	Surplus / (Deficit) 2013 to period	CN Carloads Terminated	Surplus / (Deficit) 2013 to period	CP Carloads Terminated	Surplus / (Deficit) 2013 to period	U.S. Railroad Carloads Terminated	Surplus / (Deficit) 2013 to period
2007-2008	46,264	(4,245)	24,504	(5,400)	2,727	2,465	451,226	(68,603)
2008-2009	37,034	4,985	19,294	(190)	1,303	3,889	352,494	30,129
2009-2010	40,004	2,015	24,556	(5,452)	3,243	1,949	386,983	(4,360)
2010-2011	46,874	(4,855)	28,634	(9,530)	6,065	(873)	408,145	(25,522)
2011-2012	45,717	(3,698)	24,602	(5,498)	8,337	(3,145)	394,195	(11,572)
2012-2013	44,612	(2,593)	21,108	(2,004)	9,337	(4,145)	395,644	(13,021)
2013-2014	42,019	-	19,104	-	5,192	-	382,623	-
prior 3-year avg	45,734	(3,715)	24,781	(5,677)	7,913	(2,721)	399,328	(16,705)

Source: AMS Analysis of Surface Transportation Board, *Quarterly Freight Commodity Statistics*

Table 6: Comparison of Railroad Fertilizer Movements for CSX, NS, KCS, and UP

Period (Oct. through Sep.)	CSX Carloads Terminated	Surplus / (Deficit) 2013 to period	NS Carloads Terminated	Surplus / (Deficit) 2013 to period	KCS Carloads Terminated	Surplus / (Deficit) 2013 to period	UP Carloads Terminated	Surplus / (Deficit) 2013 to period
2007-2008	280,338	(35,509)	56,543	(29,036)	1,904	(1,030)	66,177	1,217
2008-2009	227,443	17,386	29,776	(2,269)	1,739	(865)	56,502	10,892
2009-2010	246,318	(1,489)	40,463	(12,956)	1,108	(234)	59,090	8,304
2010-2011	244,950	(121)	48,445	(20,938)	1,189	(315)	66,687	707
2011-2012	240,773	4,056	36,258	(8,751)	1,170	(296)	70,277	(2,883)
2012-2013	250,234	(5,405)	32,912	(5,405)	1,084	(210)	66,802	592
2013-2014	244,829	-	27,507	-	874	-	67,394	-
prior 3-year avg	245,319	(490)	39,205	(11,698)	1,258	(384)	67,922	(528)

Source: AMS Analysis of Surface Transportation Board, *Quarterly Freight Commodity Statistics*

Although current rail metrics are showing improvement, concerns of timely fertilizer deliveries can arise in advance of 2015 spring planting. Roughly 60 percent of fertilizer is applied in the spring, and 40 percent is applied in the fall. Even though the demand for fertilizer is seasonal, it must be moved year round in order to work within the capacity constraints of the transportation network. At this time, it is unknown if the lack of rail capacity seen last fall and winter will reemerge and affect the delivery of fertilizer for spring planting in 2015.

Fall 2014 Conditions

Based on concerns over backlogged grain car orders and delayed shipments, STB issued an order on June 20, 2014, directing BNSF and CP to submit plans and a timeline for resolving their backlog of grain car orders and also to file weekly status updates on their outstanding grain car orders beginning on June 27. Both BNSF and CP stated they could resolve their orders by

October, in time for the new harvest. As of June 25, 2014, BNSF had a backlog of 8,462 grain car orders. CP's backlog was 33,229 grain car orders as of June 26.[22]

Both railroads made improvements in reducing their backlogs over the next few months, but never fully eliminated the backlogs. BNSF's backlog reached its lowest point of the year on September 10, at 1,898 grain car orders, but has been increasing ever since. On December 13, BNSF's backlog increased to 8,738 grain cars, higher than its initial status update on June 26. CP's backlog reached its lowest point of the year on October 5, at 1,871 grain car orders, and increased to a peak on November 16 at 3,283 grain car orders. CP's backlog has been slowly decreasing since reaching that peak and was 2,581 grain car orders on December 14.

BNSF and CP, the two railroads having the most severe service issues this year, haul a significant portion of the grain and oilseeds in the Upper Midwest along with Union Pacific (UP). While UP has not been experiencing severe service problems over the past year, it has still dealt with hauling 2 consecutive years of record harvests. On October 8, STB began requiring all Class I railroads to file weekly service metrics to promote transparency and service improvements. UP's first report for the week ending October 17, showed its backlog was 6,984 grain car orders. That amount peaked at 8,845 grain car orders two weeks later but steadily decreased thereafter. As of the week ending December 12, UP's backlog had fallen to 5,060 grain car orders.

Backlogs are normal during the fall peak demand for rail service following harvest. However, if the backlogs were to continue growing to the same levels reached following last year's harvest, grain shippers may experience a repeat of severe delays, poor performance, and significant premiums in the secondary railcar market could reemerge.

Average bids in the secondary railcar market for BNSF shuttle service have gradually fallen from the record high of $5,875 per car above tariff, set during the week ending October 9, to three weeks of bids trading at a discount to (below) tariff beginning the week of November 20. The most recent data available, as of December 18, show average bids for BNSF shuttle service were trading at $50 per car above tariff for January 2015 delivery. That is $2,700 less than at what bids were trading this time last year and only $106 above the 5-year average, which highlights recent improvement in rail service.

BNSF system wide cycle times for grain shuttles have begun to improve in December, averaging about 2.5 shuttle trips per month across all export regions for the week ending December 13. In mid-December, cycle times to West Texas are highest at 3.7 shuttle trains per month. Grain shuttle train cycle times to West Texas have been higher than other regions.

---

[22] The CP data at this time were not reliable because many shippers ordered more railcars than needed and were not faced with any financial penalties for doing so. Since then, CP has changed to a car-auction system that requires shippers to pay for cars ordered, reducing the instance of "phantom orders" which inflated previous estimates of the backlog.

Soy Transportation Coalition Survey Results

In the Fall of 2014, soybean producers, concerned about the rail service disruptions in the Upper Midwest, supported additional analysis by the Soy Transportation Coalition (STC). In collaboration with the University of Minnesota, the STC project aims to survey 42 grain elevators in North Dakota, South Dakota, Minnesota, and Nebraska every 2 weeks from early November through March of 2015 to determine their assessment of rail service performance. The STC survey queries users as to their thoughts on whether rail service is reliable or challenging, how rail service is impacting storage capacity at grain handling locations, and what corresponding effect, if any, rail service could present to farmer profitability in the surveyed regions. The STC also will be exploring potential harvest season exemptions—particularly for trucking—that, if instituted, could eliminate a portion of the pressure that may build due to rail service challenges.

By the end of December 2014, the surveyed elevators indicated that overall rail service in the region is improving. The STC analysis will continue to survey grain-receiving locations into March of 2015 in order to monitor how railroads continue to serve agriculture if and when severe winter weather occurs. The three reports of survey results released to date presented the following key findings: [23]

1. Two of the most recent surveys show shuttle train cycles/turns per month have been 2.1 turns per month, down from 2.2 turns in the first survey. By the first 2 weeks in December, 78 percent of the respondents reported this was faster than last year, while 22 percent reported slower than last year. However, the railroads preferred level of service is at 3 turns per month. [24]
2. In terms of past-due railcars, the latest survey showed 54 percent of the respondents reported no past due orders. Of those reporting delays, however, the waiting time has increased: average railcars were 30 days past due, up from 13.4 days in the prior survey.
3. When asked about storage capacity, in the most recent survey, ground piles were used by 55 percent of the responders, bunkers 48 percent, and bags 17 percent. At the same time, only 3 percent of the respondents reported more storage pressure than last year, down from 11 percent in the second survey.

[23] See more details at http://www.soytransportation.org/newsroom/Railservicefor2014harvestupdate.pdf.

[24] A railroad aspires to increase the number of turns per month between points of origin and destination. If achieved, railroad assets will be more fully utilized and service to customers will be enhanced. Conversely, fewer turns per month indicate declining rail service. For example, if a railroad is able to achieve three turns per month between western Minnesota, North Dakota, South Dakota, or Nebraska, that equates to a 5-day trip to export terminals in the PNW and a 5 day return trip. This 10-day round trip journey would allow a railroad to achieve three turns per month.

Based on the feedback from the survey participants, STC asserts the overall more favorable performance of the railroads in the analyzed area of the country this year as compared to last year can be attributed to the following:

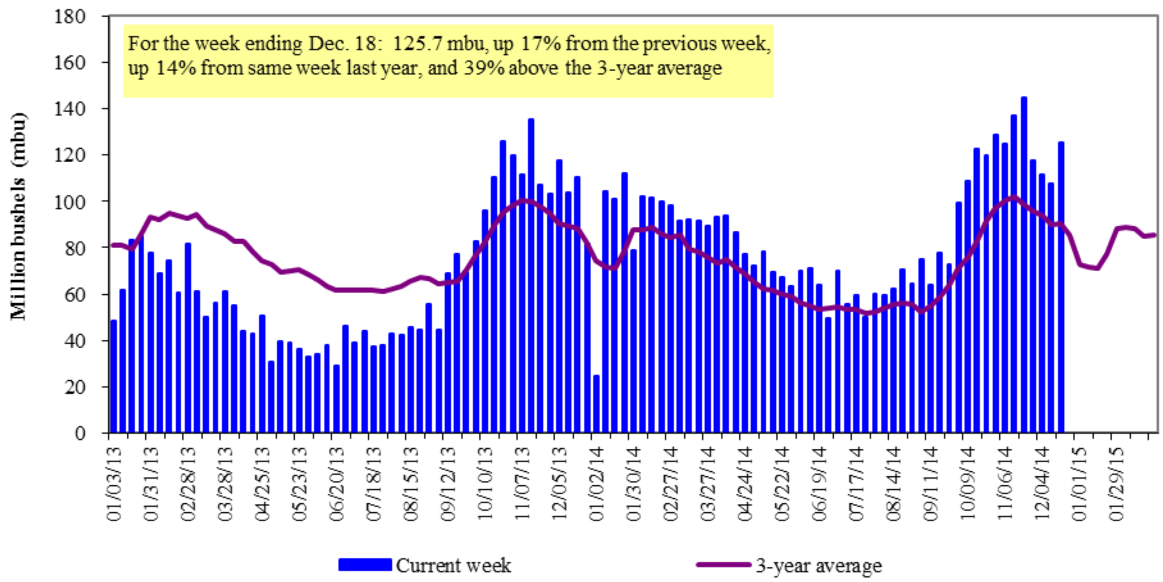
- An elongated harvest season: Because the 2014 harvest occurred over a longer-than-usual time period, railroads were better able to adjust to the volumes of grain that had to be moved. Historically, when the harvest occurs over a more condensed period, railroads are more challenged to accommodate the peak demand for service.
- Railroads have responded to demand: The railroads have responded to the increased demand with aggressive investment in locomotive power, track, and personnel.
- Farmers storing grain: Due to the recent retreat in commodity prices, farmers have elected to store more of their soybeans and grain. This has mitigated some pressure thus far on rail demand.
- Favorable weather: Although there has been some periods of significant snowfall and cold temperatures over the past couple of months, the weather overall has been favorable for transporting soybeans and grain in the surveyed areas.
- More modest harvest volumes than anticipated in some regions: Although the 2014 harvest will be regarded as large—perhaps even historic—several of the surveyed areas have reported more modest volumes than anticipated. Survey respondents mentioned "poorer crops" in certain areas and the harvest not as large "as expected."

Grain and Oilseeds Exports

Rail service issues notwithstanding, weekly U.S. exports of grain and oilseeds have been consistently higher than average shortly after the beginning of the harvest season in September 2013 (see figure 11). In fact, in October 2013 the average weekly pace of grain export inspections reached a record 115 million bushels per week, to be surpassed by the weekly pace of over 131 million bushels per week in November 2014. In addition, despite complaints of difficulties shipping grain to the Pacific Northwest (PNW), railcar deliveries to the PNW during the Fall of 2013 and 2014 were much higher than the prior 3-year average.[25] Most of the increase can be attributed to strong shipments of soybeans to China, other Asian destinations, and Mexico.

[25] USDA *Grain Transportation Report* data set for Table 3, Rail Deliveries to Port, http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateA&navID=AgriculturalTransportation&leftNav=AgriculturalTransportation&page=ATGTRDatasets&description=GTR%20Datasets

Figure 11: U.S. Grain Export Inspections



Source: AMS Analysis of USDA-Federal Grain Inspection Service (FGIS) data.

To date, the effective multimodal grain transportation system of the United States has played a major role in the 2014/15 marketing year, minimizing the effect of rail service disruptions early in the harvest on overall exports. At the same time as railroads were addressing early fall harvest rail service issues, the Mississippi River barge traffic increased by 10 percent over the previous year to meet the strong export demand.

The increased demand for barge services pushed up spot barge rates by an average of 11 percent during the peak shipping season. The record pace of grain export inspections reached in the Fall of 2014 would not have been possible without the ability of barge transportation to substitute for some segments of rail transportation.

Comparing grain export inspections by port region in the Fall of 2014, 61 percent of total grain exports were shipped through the Mississippi River Gulf, 2 points higher than last year and the prior 3-year average. The share of grain exports through the PNW accounted for 27 percent of the total, the same as last year, but 1 point lower than the prior 3-year average. The share of grain exports moving through other port regions that do not rely on the Western railroads as much (e.g. the Atlantic and Great Lakes regions) also increased in 2014 (see table 7).

Because the Mississippi River - Gulf of Mexico (GOM) port region relies on barge deliveries for most of the exports, the increased quantity of grain shipped via that port region highlights the importance of the multimodal nature of the U.S. grain transportation system. When one mode struggles with unforeseen events, grain shippers and producers rely more heavily on the other modes (trucks and barges) to meet their market obligations.

Table 7: Grain Export Inspections by Port Region, September 1 – December 25

	Fall 2013	Fall 2014	2011-13 average	Fall 2013	Fall 2014	2011-13 average
		- million bushels -			- market share (%) -	
Miss. Gulf	890	1,020	762	59%	61%	59%
TX Gulf	135	83	103	9%	5%	8%
PNW	404	459	366	27%	27%	28%
Other	88	115	69	6%	7%	5%
Total	**1,517**	**1,678**	**1,301**	**100%**	**100%**	**100%**

Source: AMS Analysis of USDA-FGIS data.

Economic Impacts on Commodity Producers

As demonstrated above, there are many factors that contribute to transportation costs and price levels across time and space. It is particularly difficult to isolate one issue and ascribe a monetary estimate of the impacts of that particular issue on specific producers or sectors of the economy, such as transportation disruptions. Below we attempt to isolate the effect of certain transportation, storage, and shipping conditions on local prices for corn, soybean, and wheat producers in the Upper Midwest. Our preliminary efforts at considering those effects show that transportation costs are a significant factor in explaining why local prices may be relatively high or low compared to nearby futures prices or spot prices at export destinations. However, the destination port, commodity, and time period are all significant in determining how much of a role rail costs affect those local prices.

Basis and Price Spreads

On any given day there is not a single price for corn in the United States but numerous local cash prices which reflect local supply and demand conditions with prices linked through the cost of shipping from one location to another. Local cash grain bids may reflect local storage availability; quality of the grain; consumption needs from large livestock feed operations, processors, or ethanol plants; the gathering and conditioning of grain for further transport to export markets; or the storage of grain for sale at a future date in anticipation of rising prices. Local markets are tied together through transportation costs and storage capacity as the local purchasers must bid for farmer supplies against other delivery options. If a location offers a cash bid below what the farmer can obtain at a more distant market, adjusted for the increase in transportation costs, and other price premiums and discounts, those bids will go unfilled. More distant delivery points, such as the Mississippi Gulf port area or the PNW ports are also linked back to Midwest supply points through the cost of transport.

Local prices at bid locations are often quoted both in a cash price and a reported ‘basis’ (see Corn Market Example in Table 8 below). The ‘basis’ is defined as the local cash price less the nearby futures contract price, and therefore represents two elements. The first element is the cost of delivery between the local origin and the futures contract delivery point. In the example below for corn that would be Chicago. The second element is storage costs from today to the date of the contract expiration (delivery). Because basis at different locations is the measurement of local prices against the same reference futures price, the discussion of comparing basis is synonymous with the discussion of comparing local prices.

Table 8: Corn Market Example: Champaign-Urbana, IL to New Orleans, LA ($/bushel)

Date	Cash Price at Origin	Cash Price at Destination	Futures	Basis at Origin	Basis at Destination	Price Spread
9/11/2014	3.17	4.05	3.32	-0.15	0.74	0.89
9/18/2014	3.07	4.13	3.38	-0.31	0.75	1.06
9/25/2014	2.91	4.08	3.26	-0.35	0.82	1.17
10/2/2014	2.81	4.02	3.23	-0.42	0.79	1.21
10/9/2014	3.03	3.92	3.45	-0.42	0.48	0.90
10/16/2014	3.14	4.13	3.52	-0.39	0.61	0.99
10/23/2014	3.20	4.23	3.60	-0.4	0.63	1.03
10/30/2014	3.33	4.54	3.74	-0.42	0.80	1.21
11/6/2014	3.38	4.52	3.71	-0.33	0.81	1.14
11/13/2014	3.56	4.70	3.86	-0.3	0.84	1.14

Source: USDA-AMS.

Like price, basis is significantly influenced by transportation costs—locations with limited transportation options and distant from significant crop demand points will consistently have a more negative basis (low relative pricing). Beyond transportation costs, local supply and demand conditions and storage availability can also cause local prices to rise (improving or strengthening basis) or fall (weakening basis) relative to the nearby futures prices. Local basis will exhibit a seasonal pattern throughout the marketing year, but can deviate from that pattern based on local and national conditions. Following the local basis, beyond just following absolute price levels, allows producers to identify marketing opportunities. Producers can use basis as a gauge of local market conditions relative to national market conditions, using an 'unusually' strong basis as an opportunity to market grain in the local market. It follows that, in years with exceptionally large crops (locally as well as nationally), limited local storage capacity, or transportation disruptions (manifested in increased transport costs or reduced shipping capacity), the basis will be weaker than normal.

Another measure for grain marketers is a comparison of prices at the origin relative to the destination, which eliminates the time and storage cost elements of the basis, but more directly reflects impacts of transportation costs. Comparing prices at the origin to prices at the destination is referred to as the 'spread' and should simply reflect the expense to ship grain to locations such as feed mills, ethanol plants and export ports. The spread between two points may be less than transportation costs between the two points, but would suggest that grain is not likely flowing between those locations at the current time. At times when the spread is greater than transportation costs, marketers will increase their demand for rail services to take advantage of arbitrage opportunities.

Similar to the basis, increases in transportation costs either through an increase in demand from a large local crop or a decrease in transportation availability through rail service disruptions will lead to a widening of the spread between origin and destination prices. A widening of the spread may be seen as a signal to producers to store the crop and wait for more favorable conditions to market their supplies, or to look for different marketing opportunities. However, with a large crop and regional differences in storage capacity, producers may have no other option than to market grain at what could be locally very low prices. Large spreads in the Upper Midwest relative to prices at ports or other regions of the U.S. may re-appear, but will remain sensitive to railcar availability.

Increases in shipping expenses, obvious in the spread, are traditionally born by the local crop producer through suppression of local crop prices. That is, the additional cost of transportation increases the spread between origin and destination prices, and that occurs primarily through a reduction in the origin price rather than an increase in the destination price. However, under certain circumstances–such as during the disruption caused by Hurricanes Katrina and Rita in 2005–the basis at origin dropped significantly and the basis at the Gulf peaked, reflecting the strong demand for grain in that location. In either case, transportation costs are born by businesses located in the United States, as the world grain market price remains the competitive constraint.

Previous Analyses

Railcar disruptions and delays and their impact on commodity prices are not new phenomena. Studies have looked at different ways to quantify the impact on grain prices due to a variety of factors in the market.

Several studies have compared the historic average basis or spread to identify times that are characterized by transportation delays or storage constraints due to large crops. Conclusions from those comparisons are valid if there is a one-to-one relationship with transportation costs and origin basis. For example, a University of Minnesota study (Usset 2014) compared the basis in Minnesota from March 2014 to May 2014 to a historic average. That 3-month comparison suggested farmers could have had revenue losses on grain marketed during that period through lower commodity prices of nearly $100 million for soybeans, corn and hard red spring wheat (HRS). The total value of the 2013 Minnesota soybean, corn, and HRS wheat crops was approximately $10 billion, so that 3-month estimated impact amounted to around 1 percent of annual revenue.[26]

Attributing the share of commodity price declines to declining rail performance ignores the complexities of the transportation and commodity marketing dynamics over time. For example, those recent studies comparing price spreads between several of the impacted States to a prior year or years, assumed similar market conditions for rail between the periods. Yet, local and national markets show cyclical increases in aggregate rail demand coming out of the recent economic recession. In addition, since the recession, localized demand for rail service has dramatically increased for ethanol, crude oil, and materials and goods needed to support the boom in unconventional oil and gas production in the Upper Midwest. Those increases in demand increase system utilization rates, amplifying the impact of any transportation disruption, such as routine track maintenance or improvements, as well as amplify the adverse impacts of severe winter weather on rail transportation speeds and overall system efficiency.

Another recent analysis by Olsen (2014) used a similar approach to determine the extent of an economic impact that increases in railroad freight rates had on North Dakota farmers from January to April 2014. He compared monthly average origin basis values from reference year 2009, also a year of a large crop in the region, to monthly average basis values for the same months in 2014. Those differences were aggregated across North Dakota to arrive at a preliminary estimate of $67 million in lost revenue for crops sold in the State in the first four months of 2014, and an additional $94 million in lost revenue if the rail service disruptions continued.

Other studies attempt to account for other variables to isolate the effect of transportation costs on local commodity prices. For example, USDA Agricultural Marketing Service considered the impact of railcar availability on grain prices (Norton, 1995). That study evaluated the impacts of a number of variables, including rail costs and availability on the spread between markets in the interior to the PNW and GOM. More recently, Wilson and Dahl (2010) summarize some of the previous literature and then estimate the impacts of rail transport costs on the basis in several locations. The authors examine how the origin basis is affected by a variety of factors, such as: shipping costs, ocean rate spreads, outstanding export sales, concentration in the grain handling industry, measures of railcars late, the ratio of grain stocks to storage capacity, future prices, and destination spreads.

Wilson and Dahl (2011) updated that study to determine impacts of fundamental factors impacting origin and destination basis using weekly observations from 2004 to 2010 for soybeans and corn. Basis values were calculated for 36 origins and multiple destinations (per

---

[26] Total crop value estimates from USDA: http://www.usda.gov/nass/PUBS/TODAYRPT/cpvl0214.pdf.

origin). Variables considered consisted of: rail rates for each origin to each destination point, barge and ocean shipping rates, storage market factors, and commodity fundamentals.

In any given week, they assume that sellers at a given origin choose a destination that maximizes the expected net returns for barge shipping (if available) and rail shipping. They constructed their data of basis values from each origin (to each corresponding net return maximizing destination) and the transportation costs to that location. Increases in transportation costs were expected to reduce origin basis. If origin and destination basis differed by only transportation costs, then those two variables should describe all the variance in origin basis. That means that the R-squared statistic associated with the regression would nearly equal one.

The authors estimated regression models for the entire data set (data pooled from all modes of transport and from all origins), models for each transportation mode, and models for each origin. In almost every case, the coefficients had the anticipated sign. The R-squared value varied from a low of 0.10 to a high of 0.80. Using the pooled data, the R-squared statistic was 0.57, which suggests that while transportation costs are an important factor in determining the spread between origin and destination prices, they are not the only factor. Of course, transportation costs and the basis at the destination are also related, which likely lowers the explanatory power of transportation costs simply on local prices.

If changes in shipping costs were paid entirely by the seller, the coefficient for transportation costs would be equal to -1.0. In the model estimated by Wilson and Dahl, the coefficient for transportation costs is equal to -0.71. That meant that changes in transportation costs were born by both buyers and sellers; i.e., transportation costs affected the origin and destination basis.

Wilson and Dahl concluded that the allocation of transportation costs depends on market conditions for the commodity in question. During times of high product demand, a larger proportion of an increase in transportation costs can be passed onto the consumer. The opposite is true during times of low demand, with proportionally more of the costs being passed onto the seller/producer. Their conclusions are consistent with traditional economic theory that suggests the burden of shipping costs is shared by the buyer and seller based on the relative elasticities of supply and demand.

The authors specified other regression models that included variables that accounted for market conditions. Two models – one for soybeans and one for corn – were estimated. Both models had relatively high R-squared statistics (0.61 for soybeans, 0.60 for corn). Significant findings included:

- Estimated parameters for transportation costs were statistically significant in both models, had the anticipated negative signs and were less than one (-0.36 for soybeans and -0.27 for corn).
- Estimated parameters for the destination basis were statistically significant in both models, and had the anticipated positive signs.

- The effect of the futures value spread (i.e., the difference between deferred and nearby futures prices) had the anticipated negative signs. That spread is an indicator of the returns to grain storage. The sign of the coefficient should be negative, meaning that larger spreads encourage storage.
- The ratio of grain stocks to storage capacity was only statistically significant in the corn model, and had the anticipated negative sign. A higher ratio reflects shortages in storage capacity which would reduce origin basis.
- The variable measuring export sales that have been made, but not shipped indicates export demand. As expected, the relationship with origin basis is positive in an increasing (nonlinear) manner. Linear and quadratic outstanding sales terms were specified in the model. Estimated parameters were statistically significant in both models, and had the anticipated signs (negative linear, positive quadratic). Increasing numbers of late cars should reduce origin basis. However, the effect of railcar placement performance (i.e., a count of the number of transport railcars that arrive late at origin points) was only found to have a modest impact on origin basis.
- The effect of higher regional industry concentration in grain handling was found to also lead to lower origin basis. Estimated parameters were statistically significant in both models, and had the anticipated negative signs. In addition, States closer to destination points generally had higher origin basis compared to those more distant.

Analysis and Data

Using readily available transportation cost data and spot price data from USDA's Agricultural Marketing Service (AMS) (see table 9) and an approach similar to Wilson and Dahl (2010 and 2011), an analysis was conducted to examine how the basis and spread have changed over time for wheat, corn, and soybeans in the Upper Midwest relative to ports in the PNW and the GOM. While the number of origin and destination pairs found in other academic studies of that issue is generally larger than those available here, the data pairings for transportation costs, basis, and origin provided sufficient variation to illustrate how transportation costs affect the prices producers received in localities relative to the prices received at port for export sales.

Here transportation costs (*Tcost*) are the sum of tariff rail rates for shuttle train shipments including fuel surcharge and cost of secondary railcar auctions. Train speed (*Speed*) is an index of average velocity by railroad normalized to an index of 100 on June 10, 2010. The ratio of quarterly grain stocks to available storage (*Stocks*) is calculated on a quarterly basis for the United States. Outstanding sales (*Out_sales*) is used to represent weekly grain and oilseed outstanding sales commitments at U.S. ports.

Table 9: Summary Data (June 2010 – November 2014)

Variable	Obs	Mean	Min	Max	Description
Port	4446	1.84211	1	3	PNW = 1; GOM = 2; Other = 3
Commodity	4446	2	1	3	wheat = 1; corn = 2; soybeans = 3
Spot Origin	3527	7.63347	2.5325	17.66	local price (dollars per bushel)
Spot Destination	1609	9.24899	3.8375	18.49	destination price (dollars per bushel)
Nearby Futures	4445	8.7134	3.2275	17.7025	futures price (dollars per bushel)
Basis Origin	3410	-0.2758	-7.555	1.9125	local basis (dollars per bushel)
Basis Destination	1642	0.93278	-9.2025	5.3225	destination basis (dollars per bushel)
Spread	1632	1.3413	-8.54	4.82	spread (dollars per bushel)
Tcost	4446	1.33325	0.57722	3.38191	rail cost (dollars per bushel)
Speed	4427	93.1647	76.5432	128.968	index of speed (June 2010 = 100)
Stocks	4446	0.59521	0.07661	1.23614	stocks to storage ratio (%)
year	4229	3.14519	1	5	2010 = 1 ---- 2014 = 5
Out_sales	4389	24.9742	6.139	46.512	outstanding sales (million metric tons)

Source: USDA-AMS (cite). Data are weekly beginning on June 10, 2010 and ending November 27, 2014. Origin-Destination pairs were selected based on available rail transportation cost data (USDA=AMS, GTR, Table 7.) Spot commodity prices are from locations near the origin-destination pairs as reported by USDA-AMS and USDA-FSA. Origin cities for wheat include: Great Falls, Montana; South Central Kansas; Chicago, Illinois; Grand Forks, North Dakota; and Northwest Kansas. Origin cities for corn include Minneapolis, Minnesota; Sioux Falls, South Dakota; Champaign-Urbana, Illinois; Lincoln, Nebraska; Des Moines, Iowa; and Council Bluffs, Iowa. Origin cities for soybeans include: Sioux Falls, South Dakota; Minneapolis, Minnesota; Fargo, North Dakota; Council Bluffs, Iowa; Toledo, Ohio; and Grand Island, Nebraska. Destination cities for wheat include: Portland, Oregon; Galveston-Houston, Texas; and Albany, New York. Destination cities for corn include: Portland, Oregon; Tacoma, Washington; New Orleans, Louisiana; Galveston-Houston, Texas; Amarillo, Texas; and Stockton, California. Destination cities for soybeans include: Tacoma, Washington; Portland, Oregon; New Orleans, Louisiana; and Huntsville, Alabama.

Two basis regressions were estimated. Model 1 examines origin basis as a function of destination basis (*Basisd*) and transportation costs. That initial regression suggests, for every $1 per bushel increase in transportation costs, the local basis is depressed by $0.262 per bushel (see table 10).

Looking at 2014, for example, the average increase in transportation costs for soybeans destined to the Gulf of Mexico from Council Bluffs, IA, relative to the prior 3 to 4 years was about $0.40 per bushel with a maximum additional increase of $1.02 per bushel.[27] Results suggest that

[27] The average increase in transportation costs (delta) in 2014 was calculated by first calculating the delta between each weekly observation in 2014 with the corresponding weekly average of observations from the previous three to four years. Because the data goes back to June 2010, there are some weeks (i.e., after June 2010) when a prior 4-year average was calculated. The average annual delta of $0.40 per bushel for soybeans, for example, is the average of all the weekly deltas.

would have depressed local soybean prices in the Upper Midwest on average by $0.11 per bushel to as much as $0.27 per bushel more than the average change in basis did in prior years.[28] As another example, wheat shipped from Grand Forks, ND, to Portland, OR, experienced higher transport costs in 2014, by about $0.69 per bushel on average and as much as $1.74 per bushel relative to the previous 3 to 4 years. Initial results suggest those higher transportation costs would lower spot prices paid to wheat producers by $0.18 per bushel on average and as much as $0.46 per bushel relative to the average during the previous three to four years. For corn sold by rail from Minneapolis, MN, to Portland, OR, the average increase in transportation costs was approximately $0.63 per bushel rising to as much as $1.62 per bushel in 2014 relative to the previous 3 to 4 years. That could have depressed local prices by $0.17 per bushel on average in 2014, to as much as $0.42 per bushel more than expected based on the previous 3 to 4 years.

Table 10: Basis Origin Factors

	Model 1		**Model 2**	
	Coefficient	**P>t**	**Coefficient**	**P>t**
Basisd	0.250	0.000	0.243	0.000
Tcost	-0.262	0.000	-0.220	0.000
Speed			0.003	0.103
Stocks			-0.210	0.005
Out_sales			-0.002	0.173
Constant	-0.297	0.000	-0.494	0.026
R-squared	0.334		0.347	
Observations	1637		1631	

Knowing what the actual impacts were for those producers is difficult to determine. It is unclear whether or not producers would have chosen to market their crop at those depressed prices, could have sold under a forward contract, could have stored the crop for sale at a later date, or even sold to shippers using a different mode of transportation. Similarly, the examples chosen may be not be representative of other pathways used to market grain and therefore the price impacts may be different leading to different estimates of costs. For example, Wilson and Dahl (2010 and 2011) calculate the revenue maximizing mode and destination for marketing corn and soybeans from the Upper Midwest, which would effectively reduce the calculated basis effects above.

Initial results using the average values from the examples above (i.e., $0.17 per bushel for corn, $0.18 per bushel for wheat, and $0.11 per bushel for soybeans) suggest the costs incurred by grain and oilseed producers in the Upper Midwest (Minnesota, North Dakota, Montana, and

[28] To estimate the basis impact of $0.11 per bushel and $0.27 per bushel, the following calculations were made: $0.262 (estimated coefficient from table 10) multiplied by $0.40 per bushel equals roughly $0.11 per bushel; $0.262 multiplied by $1.02 per bushel equals roughly $0.27 per bushel.

South Dakota), above what would be expected from regular seasonal increases in transport costs and holding all else constant from January 1 to November 30, could be as much as 3 percent of cash receipts, or about $570 million.[29] Moreover, while lower prices for corn, soybeans, and wheat will adversely affect some producer incomes, they will benefit others, such as local purchasers of those commodities.

The effect of transportation costs on local prices as represented above in Model 1 may have been more or less pronounced in different years or to different regions. Additional models are explored below to see how other factors may help our understanding of how other explanatory variables may help understand those relationships. Model 2 examines origin basis as a function of destination basis (*Basisd*), transportation cost, train speed, the stocks to storage ratio and the outstanding sales (recall table 10). The variables in question have the expected signs: increasing demand in port increases the expected price by producers; increasing transportation costs decreases the local basis; lower average velocity decreases local prices; large grain and oilseed stocks relative to storage capacity lead to lower basis; and the amount of outstanding sales at port do not appear to have a significant impact on local basis.

Importantly, transportation costs only explain about a third of the variation in basis from average levels. That is similar to findings from the earlier Wilson and Dahl analyses. As more explanatory variables are added, the explanatory power of the relationship is improved, but the actual impact of transportation costs falls slightly. That is likely due to the correlation between variables such as storage and transportation costs. By taking the difference of the basis at the origin and destination, a variable representing the spread or pure price difference between origin and destination is developed and new regressions are run (see table 11).

The transportation cost should be approximately equal to the spread since there would be arbitrage opportunities to move grain in one direction or another. Indeed the coefficient on transportation costs is near 1, confirming that relationship, but deviations from the average are not well explained by transportation costs with nearly 80 percent of the variation being explained by other factors not included in the model. The other variables do not add much to explaining why the spread may change over time. Additional variables that might help further explain that relationship are variables tracking actual shipments of grain and oilseeds by rail and by other transportation modes at different points in time.[30] It is likely that with a small spread but high transportation costs, the actual amount of grain and oilseeds moving by rail are relatively small.

---

[29] The costs incurred by producers is calculated by estimating the amount of grain and oilseeds marketed from the Upper Midwest during the January 1, 2014 through thru November 30, 2014 time period and multiplying it by the estimated change in basis implied by the average increase in transportation costs in 2014 relative to previous years. That effect could also be disaggregated further by using marketings and price impacts on a monthly basis by and to different regions, but has not been done here in the interests of time.

[30] See for example Norton (1995), who considered a large number of additional transportation variables such as monthly volumes of shipments and hopper railcar availability.

Table 11: Spread Factors

	Model 1		Model 2	
	Coefficient	**P>t**	**Coefficient**	**P>t**
Tcost	1.31	0.00	1.31	0.00
Speed			0.00	0.72
Stocks			-0.32	0.07
Out_sales			0.00	0.32
Constant	-0.37	0.00	0.05	0.92
R-squared	0.19		0.20	
Observations	1632		1626	

Results suggest that a $1 per bushel increase in transportation costs would widen the price spread between the origin and destination by as much as $1.30. Adding additional variables to the model does not seem to affect that calculation. All else being equal, a $1 increase in per bushel transportation costs should not change the spread in prices by more than $1 per bushel. That might be explained by the record rates in the primary and secondary markets during late 2013 and 2014. The transportation cost data used to estimate these models are fairly constant with little variation for the first three and a half years. The last eighteen months are different, marked by very high costs and large variations. That might explain the coefficient on transportation cost being larger than one. It is also likely that there are other costs not accounted for in the variable representing transportation costs but are correlated with transportation costs, such as storage, shipping industry concentration, trader earnings, and handling at the elevators, and hence contribute to price spreads.

Examining those relationships by year, by commodity, and by port might provide additional insights into the factors influencing price spreads (see table 12). Taking a look at the data by commodity, the effect of transportation cost on the spread at the origin appears very different across commodities.

Table 12: Commodity Spreads

	Wheat		Corn		Soybeans	
	Coefficient	**P>t**	**Coefficient**	**P>t**	**Coefficient**	**P>t**
Tcost	1.36	0.00	1.13	0.00	0.36	0.00
constant	-0.42	0.00	-0.22	0.00	0.69	0.00
R-squared	0.15		0.57		0.05	
Observations	1108		295		229	

Transport costs appear to affect price spread to a greater degree for wheat compared to corn and soybeans, perhaps due to the fact that the wheat data were limited to the Northern Plains. However, the relationship between transportation cost and spread across locations and time appears better explained by transportation costs for corn as compared to wheat and soybeans. The relationship between spreads and transportation costs is much weaker for soybeans as is the ability of transportation costs to explain movements in the spread. More data on those commodities across different origin-destination pairs would be necessary to more fully explore that finding.

Table 13: Port Spreads

	PNW		GOM	
	Coefficient	**P>t**	**Coefficient**	**P>t**
Tcost	1.32	0.00	1.45	0.00
constant	-0.28	0.00	-0.70	0.00
R-squared	0.39		0.11	
Observations	909		723	

Examining the price spreads by destination shows some variability in the ability of rail transportation costs to explain the movement of price spreads (see table 13). Transportation costs, specifically rail transportation costs, are able to explain a much larger share of the movement in price spreads between origins and the PNW port area when compared to the GOM port area. That is likely due to significant volumes of grain and oilseeds traveling to New Orleans via barge traffic from origins on the Mississippi and Illinois Rivers. In either case, transportation costs fail to explain a preponderance of movement in the price spread.

The data can be segmented to determine if circumstances in a particular year significantly influenced the ability of transportation costs to explain origin and destination price spread (see table 14). The years 2012 and 2013 show both a more limited reaction of the price spread to transportation costs, as well as a more limited ability of transportation costs to explain movements in that spread. That could be explained in part by lower volumes of product being shipped following the 2012/13 drought year, when prices were extremely high, and because transportation patterns shifted when some of the historically grain and oilseed surplus areas became areas of deficit.

Table 14: Spreads By Calendar Year

	2010		2011		2012	
	Coefficient	**P>t**	**Coefficient**	**P>t**	**Coefficient**	**P>t**
Tcost	3.50	0.00	1.99	0.00	0.81	0.00
constant	-2.71	0.00	-0.79	0.00	0.20	0.13
R-squared	0.24		0.27		0.13	
Observations	183		360		390	

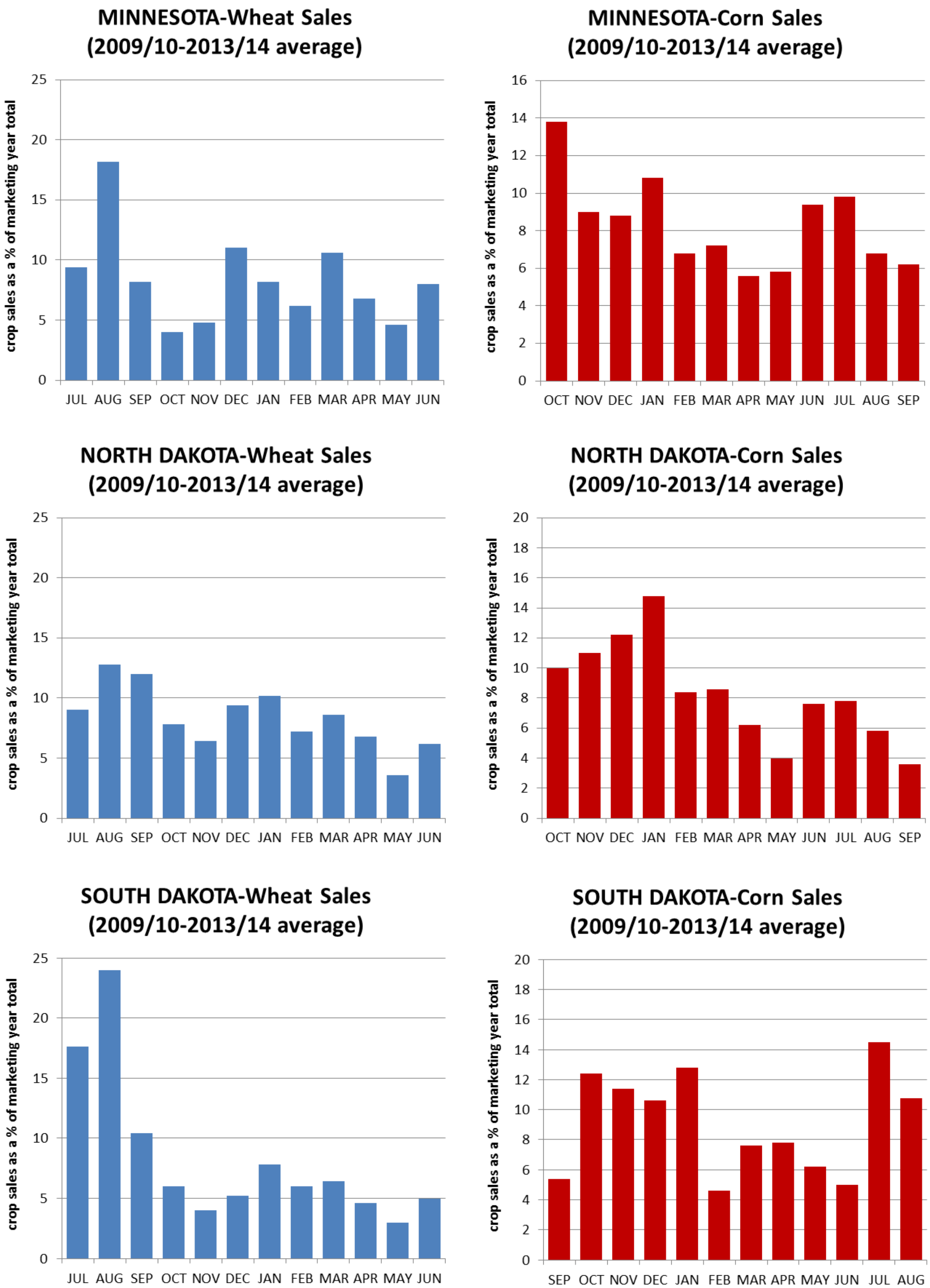
	2013		2014	
	Coefficient	**P>t**	**Coefficient**	**P>t**
Tcost	0.61	0.00	1.55	0.00
constant	0.29	0.29	-0.80	0.00
R-squared	0.03		0.52	
Observations	379		320	

Other Factors

The analysis conducted for this paper examined the relationship between spot cash prices in certain locations and how they are linked by transportation costs. However, the impact of higher transportation costs on farm income is complex. For example, the decline in commodity prices from increases in transportation costs affects all grain sold into the spot market, not just that being transported. Likewise, not all the grain is sold at harvest and not all of it is sold at spot market prices. Many producers will market their annual production throughout the marketing year to increase average crop revenue through storage and use the futures markets to hedge their price risk exposure. Crop prices often fall during harvest when supplies are most abundant. The extent to which producers can successfully mitigate their price risk exposure during periods of transportation disruptions and increased transportation costs, would reduce the negative impact of such unexpected events on farm income. Evaluating and assigning the impact of these complicated factors for all market participants is not possible because when and how individual farmers sell their grain cannot be known with certainty and its occurrence must be observed through other means.

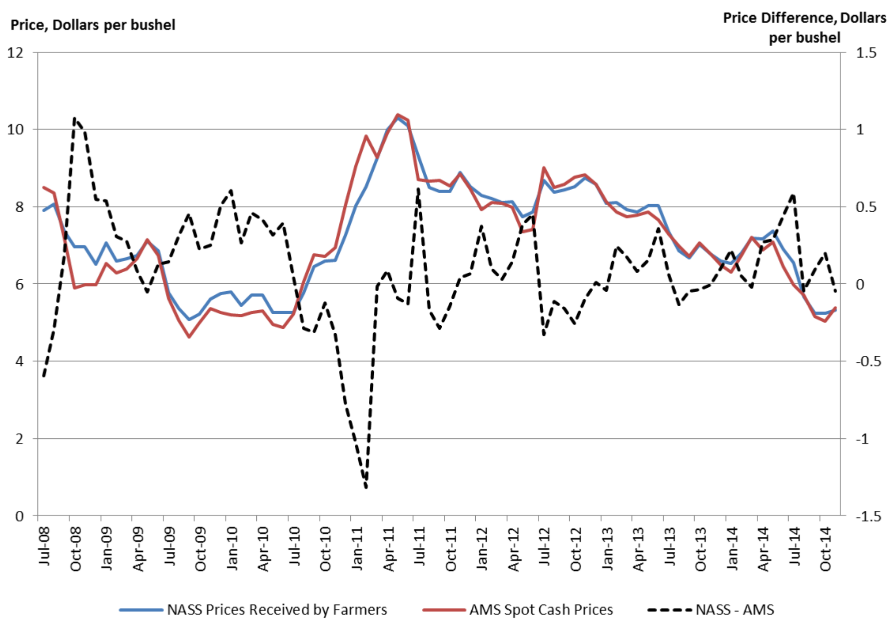
Correspondingly crop sales as a percentage of total sales as reported by NASS are often highest in the first months of the marketing year (see figure 12) as producers may have limited storage, a need for cash receipts or to hedge against price declines for the remainder of the marketing year. In North Dakota and Minnesota, a significant portion of the wheat and corn crops are sold in the latter half of the marketing year. In the event that local commodity prices decline due to temporary disruption in rail services, producers may reduce marketing until the situation improves, reducing the impact of falling spot prices.

Figure 12: Wheat Sales Patterns (MN, ND and SD in local marketing year)



Crop producers can also 'forward contract' crops for delivery at a later date, agreeing to deliver a portion of their production at an agreed upon price. Producers use forward-priced sales as a way to mitigate the risk of unexpected price declines, and in doing so, forgo the windfall of unanticipated spikes in commodity prices. Spot prices, as reported by USDA's Agricultural Marketing Service (AMS), are location bids for immediate delivery of grain and oilseeds not currently under contract, while reported prices received by farmers, as reported by National Agricultural Statistics Service (NASS), reflect the price farmers received for all crops delivered in a given time period and include crops which were delivered in that time period under a forward contract agreement.

Figure 13: Spot Price for Wheat vs Prices Paid to Farmers (SD)



Because NASS prices include the grain delivered on a forward contract, they tend to rise more slowly than spot prices during price spikes and fall more slowly during rapid price declines (see figure 13). The cash spot price is the average monthly AMS reported price for US No. 1 Dark Northern Spring wheat at East River- So., South Dakota, for cash delivery at country elevators by truck. The wheat prices received by farmers are monthly South Dakota State-level prices for spring wheat excluding durum as reported by NASS.

The impact of price risk management, storage, or forward contracting is to smooth commodity prices received by producers and stabilize farm income. To the extent that railroad disruptions caused declines in commodity prices that were unanticipated, grain under forward contract would be isolated from such movements or could be stored until prices recover. Thus, even if one could isolate the spot market price impacts, that could overstate the impact on cash receipts and farm income from the temporary shock. However, the extent to which storage and forward contracting can smooth prices received by producers is limited to a particular crop year. As disruptions in rail service have persisted for more than a year, it is likely that forwarded contracts would have reflected expected transportation cost increases.

Conclusions

Several factors came together in the Fall and Winter of 2013 resulting in significant challenges for rail shippers in the Upper Midwest, which persisted into the Fall of 2014. With fewer transportation alternatives, agricultural producers in that region are more exposed to rail prices, which influence the prices they receive for their crops in the local market. Rail service degradation contributed to a surge in the price of railcars in the secondary and primary railcar markets, which further pushed down crop prices in the local market at a time when national prices for grain were falling.

Our preliminary efforts show that transportation costs are a significant factor in explaining why local prices may be relatively high or low compared to nearby futures prices or spot prices at export destinations in the PWN or the GOM. We show that the destination port, commodity, and time period are all significant in determining how much of a role rail costs affect those local prices. Initial results suggest that rail transportation cost increases for corn, wheat, and soybeans from the Upper Midwest to the PNW and to the GOM could have depressed local crop prices on average by between $0.11 per bushel to as much as $0.18 per bushel in 2014.

Those price impacts are similar to earlier studies that also show a large degree of uncertainty in the explanatory power of transportation rail costs to explain changes in local commodity prices. Lack of this explanatory power makes it difficult to assign a monetary estimate of the impacts of rail service disruptions on local prices for wheat, corn, and soybeans.

Those lower commodity prices have a direct effect on farm income, reducing crop receipts for the season. In addition, these lower prices, as a result of transportation disruptions, are not just for grain sold and shipped outside of the area, but impact prices for all grain sold in the region and thus are a source of concern for agricultural producers in those areas.

Knowing what the actual impacts were for affected producers is difficult to determine. It is unclear whether or not producers would have chosen to market their crop at those depressed prices, could have sold under a forward contract, could have stored the crop for sale at a later date, or even sold to shippers using a different mode of transportation. Initial results using the average values from the examples above suggest the costs incurred by grain and oilseed producers in the Upper Midwest (Minnesota, North Dakota, Montana, and South Dakota), above what would be expected from regular seasonal increases in transport costs and holding all else constant from January 1 to November 30, could be as much as three percent of cash receipts.

More detailed analyses have included other factors not directly associated with transportation rates and performance to explain changes in local commodity prices, and show that there remain many outside factors that cause local prices to deviate from historical patterns. The simple regressions we conducted above on available data between 2010 and 2014 suggest similar constraints on explanatory power. While grain stocks, train speed, and transportation costs are all significant in explaining the spread in prices between origin and destination, other unidentified factors are significant as shown by the model's fit statistics. That is to say, much of the basis and price spread remains unexplained.

The estimated impact of increased transportation costs on crop cash receipts is a rough estimate—some of these impacts may have been mitigated until local prices recovered through forward pricing or storage of grains and oilseeds but additional impacts not reflected through local prices may not be fully captured in the estimate. For example, we do not know how producers and shippers responded to unfavorable prices for shipping by rail. Some could have decided to store their product; others may have chosen to use other transportation modes to fulfill their contracts. In addition, there were other losses grain shippers sustained, including the costs of the increased time grain was in storage, and losses due to falling grain prices that occurred while waiting to obtain transportation for the grain. Some ethanol plants were forced to cease or reduce operations for a period of time, which entailed costs to the ethanol plants and resulted in the loss of local markets for the grain producers, further depressing grain prices. With additional data on other origin-destination pairs, as well as on rates and volumes of grain and oilseeds moved by other modes of transport, on storage costs, and on the contracting between producers, shippers and buyers, those regressions could likely be improved to show other determinants of basis and price spreads across regions of the United States. Yet, even with additional data and more explanatory variables, academic studies on those issues still show a good deal of unexplained variance in the estimated relationships.

Nevertheless, it does not appear that the high transportation costs impeded the ability to meet our export demand, suggesting other transportation modes or routes and the storage and contracting of grain and oilseeds over time helped mitigate the rail disruptions last winter and the relatively high prices for railcars in the secondary markets this fall. Exports of grain and oilseeds in 2014 are above the 3-year average. The extremely high price of railcars on the secondary market in recent months has fallen to normal levels as anticipated shipping problems for the majority of shippers have thus far not materialized late in 2014.

Citations

Association of American Railroads (2014). *Ten-Year Trends, 2003-2012* (July; available at https://www.aar.org/Pages/Product-Details.aspx?ProductCode=RTYT2012).

Association of American Railroads (2014). *Weekly Railroad Traffic* (December; available at https://www.aar.org/data-center/rail-traffic-data).

General Electric Corporation (2012). *GE Works: 2012 Annual Report* (available at http://www.ge.com/ar2012/pdf/GE_AR12.pdf

Government Accountability Office (2014). *Freight Transportation: Developing National Strategy Would Benefit from Added Focus on Community Congestion Impacts*, GAO-14-740. (September 19).

International Fertilizer Development Center (2014). *North America Fertilizer Capacity* (March*;* available at http://www.ifdc.org/Media Center/Publications/IFDC Publications/Fertilizer Market-Related Reports).

Iowa Department of Transportation (2014) *Barge Comparison Chart* (available at http://www.iowadot.gov/compare.pdf).

Norton, Jerry D. (1995) *Assessing the Impact of Railcar Availability on Grain Prices*, U.S. Department of Agriculture, Agricultural Marketing Service (September).

Olson, Frayne (2014) "Effects of 2013/14 Rail Transportation Problems on North Dakota Farm Income: Executive Summary to Senator Heidi Heitkamp," preliminary economic analysis (available at http://www.heitkamp.senate.gov/public/_cache/files/0f76d4f2-c117-4537-8fc0-8a9d3894c480/effects-of-rail-transportation-problems.pdf).

Prater, Marvin E., Adam Sparger, Pierre Bahizi, and Daniel O'Neil, Jr. (2013) *Rail's Loss of Grain Transportation Market Share*, U.S. Department of Agriculture, Agricultural Marketing Service (December).

Sparger, Adam, and Nick Marathon, (2013) *Transportation of U.S. Grains: A Modal Share Analysis*. U.S. Dept. of Agriculture, Agricultural Marketing Service (May).

Soy Transportation Coalition (2014) "2014 Harvest: Attaching a Garden Hose to a Fire Hydrant," survey response update (December 8; available at http://www.soytransportation.org/newsroom/Railservicefor2014harvestupdate.pdf).

U.S. Dept. of Agriculture, Agricultural Marketing Service (2013). *Grain Transportation Report* (October 31; available at http://dx.doi.org/10.9752/TS056.10-31-2013).

U.S. Dept. of Agriculture, Agricultural Marketing Service (2014). *Grain Transportation Report* (July 10; available at http://dx.doi.org/10.9752/TS056.07-10-2014).

U.S. Dept. of Agriculture, Economic Research Service (2012). *Chemical inputs* (November; available at http://www.ers.usda.gov/topics/farm-practices-management/chemical inputs.aspx).

U.S. Dept. of Transportation, Bureau of Transportation Statistics, and U.S. Census Bureau, (2010), *Commodity Flow Survey*, *2007*. Report EC07TCF-US (April; available at http://www.census.gov/prod/2010pubs/ec07tcf-us.pdf).

U.S. Dept. of Transportation, Surface Transportation Board (2013), *Fall Peak Letters* (available at http://www.stb.dot.gov/peakletters1.nsf).

Usset, Edward. (2014) "Minnesota Basis Analysis: Preliminary Report for the Minnesota Department of Agriculture," Center for Farm Financial Management, University of Minnesota (July).

Wilson, William W. and Bruce Dahl (2010) "Grain Pricing and Transportation: Dynamics and Changes in Markets," Agribusiness and Applied Economics Report No. 674, North Dakota State University (December)

Wilson, William W. and Bruce Dahl (2011), **"**Grain Pricing and Transportation: Dynamics and Changes in Markets" *Agribusiness Journal*, 27 (4) 420-434.